FOURTH QUARTER 2018

Goehring & Rozencwajg
Natural Resource Market Commentary

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OIL BULL MARKETS PAST & PRESENT, AND YELLOW JACKETS

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Introduction

"Schlumberger Ltd., the oil-field-services giant, reported in a research paper that secondary shale wells completed near older, initial wells in West Texas have been as much as 30% less productive that the initial ones. The problem threatens to upend growth projections for America's hottest oil field, the company said in October." Wall Street Journal 1/3/2019

"Global oil demand still grows significantly, but where will the supply come from is a key question.... To be honest with you, the investment appetite is very weak. We cannot expect the US shale alone to fill the gap between demand and weak conventional projects, the US shales do an excellent job, but we cannot expect everything from the shales. If we are to avoid a supply crunch we need the US shales to increase in the next seven years more than 10 mm b/d, which means the US shales have to add more than one Russia, even more than that, and if this doesn't happen, prices will be pushed up, and this is not good news for anybody."
Bloomberg Interview, Fatih Birol, Executive Director, International Energy Agency 11/13/2018

"Current French President Emmanuel Macron has persisted in promoting a massively punitive 'green' fiscal policy that disproportionally targets the working back of French society. Overload it, and it's eventually going to snap." Chicago Tribune, 1/4/2019

In a move that caught a huge number of energy investors and traders (including us) completely off guard, oil prices collapsed in Q4. After peaking at $86 per barrel in the first week of October, Brent oil prices began to pull back relentlessly. As we write, oil prices have now pulled back 30% and Brent

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prices stand at $60. Although the oil price pullback has been much sharper than anything we expected, we want to vigorously stress that pullbacks in developing bull markets oftentimes occur and are many times severe. Also, we want to stress to our readership base, that the current pullback in oil prices has not changed in any way our long term bullish outlook on global oil markets. We believe the pullback in oil-related investments has again presented oil investors with another excellent buying opportunity.

"THE CURRENT PULLBACK IN OIL PRICES HAS NOT CHANGED IN ANY WAY OUR LONG TERM BULLISH OUTLOOK ON GLOBAL OIL MARKETS."

We believe the pullback in today's oil prices closely resembles the oil price action that occurred at the beginning of the great oil bull market that started 20 years ago. For readers who want historical context, oil prices bottomed at $10.72 per barrel in December 1998, in a spasm of near panic selling. After making a double bottom in January 1999, OPEC agreed to cut production by 1.7 mm b/d in April and oil prices rallied strongly, eventually surpassing $37 per barrel by September 2000. In response to oil prices that had climbed to over $30, OPEC agreed to two production increases (in April and again in July of 2000), which added back over 2.4 mm b/d of additional production. Oil prices pulled back into the high $20s in the next 12 months as investors began to worry over demand destruction and increases in non-OPEC oil supply. Then 9/11 hit. Driven by fears of collapsing global demand related to the terrorist attacks, oil pulled back over 40%, eventually bottoming at $17 per barrel in November 2001. The pullback in oil prices produced a wildly bearish investment backdrop for energy investors--a situation similar to today. Even though oil prices had begun to rebound, energy stocks in 2002 made new cycle lows. For example, the XLE, which at the time was the most widely followed energy ETF, made a new low in the summer of 2002, even though high prices had rebounded to $30 per barrel, 175% above its $11 cycle low.

In retrospect we all know that huge misunderstandings regarding both future supply and demand, combined with rampant bearishness, had set the stage for an epic surge in oil prices that would take place over the next six years.

In many ways, we believe we are repeating the 1999-2002 experience. Oil prices bottomed in panic selling back in the first quarter of 2016, just as they did back in 1999. In fact, we would make the case the selling pressure in 2016 was an order of magnitude greater than in 1999. For example, if you price oil in terms of gold, one ounce bought 30 barrels in 1999---an extremely high number that historically signifies a significant oil price bottom. In this cycle by February 2016, one ounce bought 45 barrels — the highest level we have ever seen in the 160 years of data that we keep. (For those interested in financial history, the previous record in the gold-oil ratio was achieved at the bottom of the Great Depression in 1934 when an ounce of gold purchased 36 barrels of oil.)

And just like the pullback of 2001, the pullback in oil in the second half of 2018 created a huge surge of bearish market sentiment. In 2001, the underlying fundamentals in global oil markets had improved dramatically from 1999. Oil demand, led by the non-OECD world, was about to surge and non-OPEC oil supply was about to hugely disappoint. Few energy analysts anticipated these huge changes about to take place.

Today, we believe we are in the same spot. As we will discuss in the "Oil Commentary," oil market fundamentals are very different than three years ago, and show a strong similarity to the bullish trends of 2001. First, non-OPEC oil supply, which today still represents almost 60% of world oil supply, is set to disappoint significantly as we progress into the coming decade. In past letters, we have explained how we identify upcoming disappointments. These underlying problems are now being recognized by the most important of energy market watchers. For those with access to Bloomberg, please watch the November

13, 2018 interview with Dr. Fatih Birol, the Executive Director of the International Energy Agency. Dr. Birol presents a thesis very similar to ours. Dr. Birol believes the biggest risk to global oil markets in coming years is not oversupply, but rather dramatic and unexpected disappointments in conventional non-OPEC oil production. These shortfalls will have to be replaced with shale production growth, an extremely difficult task. We concur: the coming disappointments in conventional non-OPEC supply will be the most important driver of the oil market over the next five years.

"THE BIGGEST RISK TO GLOBAL OIL MARKETS IN COMING YEARS IS NOT OVERSUPPLY, BUT RATHER DRAMATIC AND UNEXPECTED DISAPPOINTMENTS IN CONVENTIONAL NON-OPEC OIL PRODUCTION."

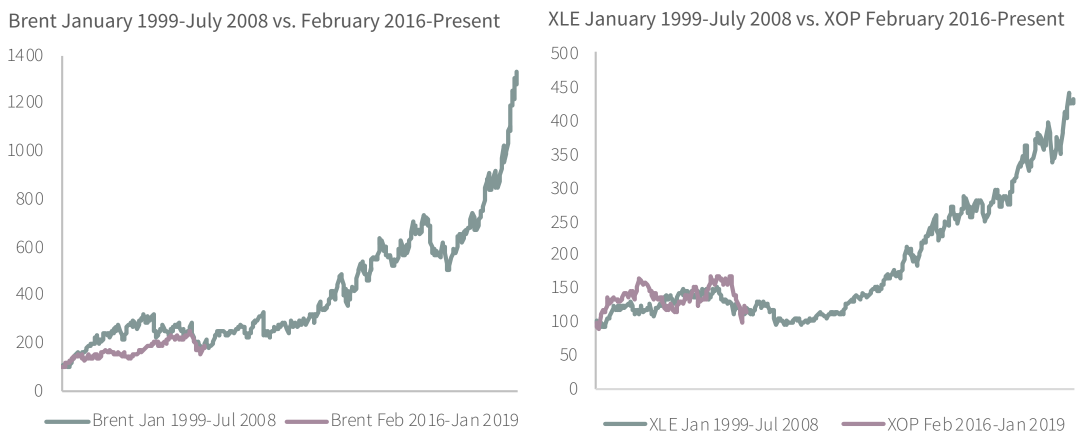
Second, we believe OPEC's position in today's oil market is radically different than it was four years ago. Back in 2014, the Saudis began a price war to deprive their deep-seated adversary Iran the necessary oil revenue needed to carry out its plans for Middle East expansion. After the Saudis boosted their production by over 1 mm barrel per day in the first six months of 2015, the Obama administration concluded the Iranian nuclear deal and lifted sanctions on the sale of Iranian oil-- something the Saudis did not foresee at the end of 2014. In the first six months of 2016, Iran's oil production surged by almost 1 mm barrels per day. By then, the Saudis realized they had started a price war they could not win. In response to OPEC's surging supply, total global inventories rose to reach a record 3.2 billion barrels in May 2016. Although there are similarities today to what happened three years ago (for example, Iran is again the central issue), we believe conditions in global oil markets are now vastly different. When Trump re-imposed Iranian sanctions this summer, most analysts believed they would remove up to 2 mm b/d of Iranian oil from world markets. In response to pressure from President Trump, the Saudis, and the rest of OPEC, increased production by almost 1.5 mm b/d. Then, instead of sanctioning Iranian oil, Trump granted waivers to Iran's largest crude buyers, thereby throwing the Saudis "under the bus" and creating a temporary market oversupply. However, as opposed to the 2014-2015 experience, the Saudis, with OPEC's collaboration, have quickly agreed to remove this unnecessary oil from global markets by cutting production.

As mentioned above, we have been here before in recent history. Oil bottomed in January 1999 at $11 per barrel in a spasm of panic selling that saw the oil prices fall far below prices needed to justify investments in new projects. Oil proceeded to rally a huge 250% over the next eighteen months. However, by the fall of 2000, oil prices began to slip and almost all analysts believed the market would be in significant surplus for many years. After the 9/11 attacks, everyone assumed that global oil demand would collapse. For example, after estimating that 2002 oil demand would grow by almost 1.0 mm b/d before the attacks, the IEA reduced its demand estimate by a huge 80%. By the end of 2001, the IEA projected 2002 oil demand would grow by only 200,000 b/d and even as late as that summer they maintained the same view.

Because of collapsing demand estimates, everyone assumed 2002 would see a market in extreme surplus and OPEC agreed to four production cuts between February 2001 and January 2002. Although compliance was low, actual OPEC cuts eventually reached over 3 mm b/d. In retrospect, the IEA's demand estimates for 2001 and 2002 were wildly off the mark. Although demand did falter after the 9/11 attacks, the magnitude was nowhere near bearish projections put out by the IEA. Instead of expected growth in 2001 and 2002 of 300,000 b/d as originally projected by the IEA, the final figures showed global demand growth of 1.2 mm b/d. The underestimation of global oil demand growth, (led by the non-OECD world), was about to fall into a repetitive pattern that continues today. Regarding supply, starting in 2003, the IEA went on a five-year stretch of overestimating non-OPEC oil supply by almost 1 mm b/d per year. Unanticipated strength in demand combined with disappointments in non-OPEC oil supply drove the oil market to advance over eight times in price from its $17 low reached in 2001. But back in 2001 and 2002, none of these beliefs were widely accepted, and instead energy investors had reached a climax in bearish psychology. By the beginning of 2003, energy representation in the S&P 500 reached 5.2%, a figure we believe to be a 50-year low, and rivaled only by the S&P 500's energy representation reached in December of last year— again 5.2%.

In many ways we are again in the same position as 2002. Because of the temporary imbalance in global oil markets, prices pulled back, and have now stabilized some 60-65% above their 2016 cycle-lows, (just as they did in 2001). Because of the US Federal Reserve quantitative tightening, Trump trade wars, and worries over potential debt problems in China, investors and energy market commenters believe we will to see significant downward revisions in 2019 and 2020 global oil demand (also similar to 2001). Finally, we believe we're going to see a significant overestimate of future non-OPEC oil supply, just as we did back in 2001.

CHART 1 Brent/XLE/XOP Past & Present



Source: Bloomberg

Bearish consensus in 2001 produced a tremendous buying opportunity in energy-related investments. Has the current level of bearishness produced a similar buying opportunity? We think so and in the oil section we will go over how the underlying supply-demand fundamentals will play out in 2019. Eighteen years ago, energy investors incorrectly judged the future of both demand and supply and we believe the same dynamic is playing out today. We are more convinced than ever that global oil markets have entered a multi-year bull market and that the 35% pullback in oil in the last three months has created another superb buying opportunity.

I was in southern France in the last week of November and my wife and I had multiple contacts with the "yellow vests" as we drove from the Spanish border to Perpignan and Carcassonne. We experienced first-hand the agitation generated by the French government's decision to raise the tax on diesel fuel. At many of the motorway's toll booths, the "yellow vests" had broken the toll barriers and blockaded the use of both entrance and exit ramps. As we tried to move through the broken toll barriers, we were forced by mobs that many times exceeded 50 demonstrators to pay bribes to both enter and exit from the motorways. Although the ensuing "yellow-vest" riots in Paris garnered significant media attention, we at Goehring & Rozencwajg are fascinated by the media's contortions to avoid discussing the underlying reasons for the uprisings.

In past letters, we have laid out two possible scenarios for the widespread adoption of electric vehicles: either the governments would heavily subsidize EV purchases (as Norway does today) or tax (or outright outlaw) the purchase and use of internal combustions engines (ICEs). Our Q1 2018 letter discussed how unfavorably the "energetics" of the EV compare to those of the internal combustion engine. Because of an EV's inferior energetics, it costs more to purchase and run and EV than an ICE passenger car—a situation we believe will continue even with anticipated advances in battery technology. We also pointed out that there has never been an instance in the history of civilization where a new technology with inferior "energetics" has replaced an older technologies with superior "energetics." As an example, we like to bring up the plight of the Concorde supersonic transport jet. Developed for billions of dollars in the late 1960s by a consortium of European governments, the Concorde was a technological marvel that cut the flying time between Europe and the United States in half. The plane became a favorite of the Hollywood elite, rock stars, and investment bankers, but after 27 years of being heavily subsidized by British Airways and Air France, the Concorde disappeared. Why? The answer is simple: the Concorde tried to replace an older technology (in this case the subsonic jet) with a new technology with vastly inferior "energetics." Although the Concorde cut flying time in half, it required 900 liters of fuel per passenger to fly between London and New York. The Boeing 747, flying the same route, required only 250 liters of fuel per passenger. Even with the benefit of a quicker flight, the inferior "energetics" of the Concorde raised the cost far above what the average transatlantic passenger could bear.

Although not completely comparable, we believe we are in a similar situation today with the EVs versus ICEs. On a strict purchase and operating cost basis, the average consumer would never buy an EV. But in one way, the Concorde and EV look the same. Buyers of EVs at present (using Teslas here in the US, for example) are rock stars, Hollywood elites, and investment bankers. Although it's still early in the EV evolution, seeing Tesla buyers who look just like former Concorde users is something our study of "energetics" would strongly suggest would happen.

Another recent announcement emphasizes this point. General Motors (GM) just announced the discontinuation of the Chevy Volt, a plug-in hybrid vehicle brought out under the Chevy brand—a brand traditionally associated with middle-class buyers. GM discontinued the Volt in order to "prioritize investments in its next-generation battery-electric architectures." And what might that new "investment" look like? Six weeks after the Chevy Volt announcement, GM announced their first "lead electric vehicle brand," which will be produced under their Cadillac brand—one historically associated with high-income buyers. In their announcement of the new EV, GM said the new Cadillac EV "will represent the height of luxury." Given our belief in the inferior "energetics" of the EV, we could have predicted that GM would position their EV to "luxury" buyers. Only the upper-class are in a position to pay for a vehicle despite its much poorer "energetics."

And this is where the "yellow vests" come in. The only way your average passenger car buyer will consider purchasing a vehicle with inferior energetics is one of two ways (or a combination of both). Governments will subsidize the purchase of EVs or they will restrict or tax the purchase of ICEs. Without either of these two government policies, consumers will continually favor the vehicle with far superior "energetics"—in this case the ICE. Although France has not really even begun its EV journey, it is beginning to look like Macron and the French government have decided to follow the second route regarding the ICE—that is taxation and restriction. "France to increase tax on diesel fuel as country prepares for electric future" reads the headline on the Autovista Group (a European automotive consulting firm) website.

But a major problem has emerged in the French government's push to force out and possibly outlaw the internal combustion engine. Huge segments of the population are starting to rebel as the true cost of EV ownership becomes more transparent. The cost to switch to EVs can be absorbed by rock stars, Hollywood royalty, and investment bankers, but what of the cost to the average French citizen? We have repeatedly told our investors that the switch to electric vehicles could be potentially extremely painful. At some point, the true cost and resulting pain will become apparent. The working-class people of France are now beginning to feel and rebel against these costs, even though the introduction of high cost EVs into France hasn't even started in earnest.

"THE WORKING-CLASS PEOPLE OF FRANCE ARE NOW BEGINNING TO FEEL AND REBEL AGAINST THESE COSTS, EVEN THOUGH THE INTRODUCTION OF HIGH COST EVS INTO FRANCE HASN'T EVEN STARTED IN EARNEST."

We believe this "yellow vest" controversy could have a material impact on future oil demand growth assumption. In the very near future, we foresee additional scrutiny on EVs and renewable electricity generation, both in terms of the true costs to undertake these ventures, and their impact on CO2 emissions. There is an irony in what France is attempting to do. Many years ago, France made the decision to generate 70% of its electricity with nuclear power which has had a positive impact on its CO2 output. For example, even though France's per capita GDP is only 13% less than Germany's, France's per capita CO2 output is almost 50% less. Yet France, for reasons that are completely unclear, has signaled that it wants to emulate its eastern neighbor. Germany has spent $1 trillion on renewable investments, while also making the monumental decision to scrap its nuclear power industry. As a result, Germany's CO2 output refuses to fall and its cost to produce electricity continues to rise. Macron has made announcements that he wants to undertake policies that will wind up replicating these results. The people who will bear these costs, the middle class, are starting to rebel.

An honest discussion of the true costs of renewables and EVs could potentially produce backlashes as the high costs of both technologies are eventually recognized. The "yellow vests" could be the first of many similar movements as these costs become better understood. One of the most widely-held investment themes to emerge in the last five years has been the concept of peak oil demand. Because of skyrocketing adoption of EVs for transportation, global oil demand is expected to peak and eventually begin to decline beginning in about 10 years, or so says today's consensus opinion. But as we have warned, these assumptions are based on the introductions of new technologies (new battery technologies for both transportation and grid-level storage) that as of today do not exist. Although we believe EVs powered by renewable energy will someday become dominant, we suspect that most analysts are aggressively overestimating their short-term penetration and the impact on global oil demand in the next 10 years.

Q4 2018 Natural Resource Market Commentary

"COMMODITY MARKETS DRIVEN PRIMARILY BY PHYSICAL BUYERS AND SELLERS HAVE VASTLY OUTPERFORMED COMMODITY MARKETS DRIVEN PRINCIPALLY BY FINANCIAL PLAYERS."

In the face of continued US Fed quantitative tightening, continued trade war rhetoric regarding China, and escalating worries over slower global growth, natural resource markets pulled back significantly in Q4. Although global resource markets were fixated on oil's huge price pullback and the potential negative implications of global growth, an interesting divergence took place which few analysts noticed. Continuing a trend that began last summer, commodity markets driven primarily by physical buyers and sellers have vastly outperformed commodity markets driven principally by financial players. For example, iron ore, metallurgical coal, and uranium—all markets little influenced by financial players-- have actually seen prices rise in the last six months. In comparison, the base metal complex has fallen 25% while oil has fallen over 30%. This divergence continued in Q4. As the Fed continued tightening -- by both raising interest rates and letting its balance sheet shrink—the base metal complex fell an average of 10%, oil prices fell 35%, while iron ore, metallurgical coal, and uranium prices all rose over 3%. The weakness in base metals and oil implies that global growth is about to slow significantly in the coming years, and yet the strength in both iron ore and met coal indicates that growth, primarily in China, remains solid. Given the huge impact of economic growth on these markets and, given that there is little difference in supply-demand fundamentals between iron ore, coking coal, uranium and the base metal complex (as we have discussed, oil has a temporary imbalance), we find this discrepancy curious and will monitor it closely. Could it be that Federal Reserve quantitative tightening is putting pressure on markets that are influenced by highly leveraged financial players, but bypassing commodity markets that are dominated by physical buyers? In previous global growth scares (for example in 2008-2009 and in 2015), the price of oil, base metals, iron ore, and global coal all fell together. Is today's divergence between these markets telling us that global growth fears are being exaggerated? Chinese copper consumption trends in the first 10 months of 2018 bear this out. As we progressed through 2018, Chinese copper consumption grew at the fastest rate in three years while Chinese oil consumption continued to accelerate. Given that the Fed now looks to be slowing their quantitative tightening and with the huge amounts of additional stimulus the Chinese government has injected into its markets (for example, the Chinese Central Bank just cut bank reserve requirements last week), we believe our bullish estimates could actually be overly conservative.

The dominating event in global resource markets in Q4 was the near-collapse in oil prices. Temporary imbalances, caused by Trump-inspired OPEC production increases, combined with the unexpected waivers issued to a significant number of sanctioned Iranian oil buyers, caused oil prices to pull back significantly. For the quarter, West Texas Intermediate prices fell 38% and Brent prices fell 34%. Energy-related stocks were also extremely weak during the quarter. For example, the S&P Oil and Gas Production ETF, fell 39% and the OIH, the most widely followed oil service ETF, fell 43%. Global oil inventories receded significantly throughout 2018 and oil prices had advanced over 35% by the end of September. Talk of oil moving significantly higher than $100 per barrel emerged in the press as everyone expected significant drops in Iranian exports. Oil prices peaked in the first week of October, with Brent surpassing $86 per barrel. Trump then unexpectedly announced waivers to multiple Iranian crude buyers and global oil markets found themselves unexpectedly oversupplied with 1.5 mm b/d of oil of additional OPEC supply. After the shock of Trump's announcement, oil prices in Q4 pulled back almost 40%, implying a global oil market that was in a serious state of disequilibrium. However, our inventory analysis portrays a market that is in only slight surplus. In response to increases in OPEC's production which started at the end of May, global oil inventories have moved up countercyclically, but the magnitude of the increase again shows the persistence and underestimation of strong demand. For example, over the last 200 days, we believe OPEC has added close to 200 mm barrels of extra supply to global oil markets and yet, inventories (when adjusted for seasonal factors), have only increased by 25 mm barrels. In response to the near collapse in oil prices, OPEC cut production by 1.2 mm b/d at the end of December. We believe these cuts will quickly turn the oil market's slight surplus into a strong deficit as we progress into 2019. Although no two periods are alike, our research today tells us we are now set to repeat the 2002-2005 experience. As 2019 starts, we believe we are under-estimating the forces that are driving global demand in the coming years as well as the forces that are driving conventional non-OPEC supply—a situation not dissimilar to what happened when oil prices bottomed at $17 per barrel in Q4 of 2001. We are repeating the trajectory of oil prices that started 20 years ago. It won't be long before the financial press returns to talking of $100 oil.

Natural gas prices had a wild ride in Q4. In last quarter's letter, we raised the possibility of seeing a significant weather-related spike as we progressed through the 2018-2019 withdrawal season.

Because of an extremely cold spring, natural gas markets didn't begin the injection season until the last week in April—the latest in all the records we keep. The cold spring combined with the fourth hottest summer in US history resulted in inventories approximately 15% below 10-year averages at the end of the injection season. Low inventory levels, combined with a period of prolonged cold weather, put severe upward pressure on gas prices as we entered the withdrawal season. November experienced a month-long period of much-colder than normal temperature. Natural gas prices started Q4 at $3.08 per mmbtu and spiked by over 50% to reach almost $4.80 per mmbtu by the end of November. As weather forecasts for prolonged cold weather receded, prices collapsed, finishing at $2.94 per mmbtu, below where they started the quarter. Although we warned of a potential price spike in our last letter, we also reiterated our long-term neutral opinion on North America natural gas markets. Because of the onslaught of continued new supply (the Marcellus, Utica, Scoop/Stack, and now surging production from the Delaware side of the Permian basin), we believe that any price spike will be short lived. US natural gas supply in 2018 surged by over 10 bcf/d--an incredible 11%, even though the 2018 natural gas rig count only grew by 18 rigs (from 172 to 190). We don't see any let-up in supply growth in 2019. Demand growth in 2019 will be driven by over 5 bcf/d in new LNG export capacity, however, if our models are correct and supply continues to surge, we believe 2019 will be another years of depressed gas prices. Having said that, we believe we run the risk for another weather-related spike in gas prices as we progress through the next three months of winter. Weather models are strongly suggesting a prolonged cold spell will grip both Europe and North America in the second half of this winter. Given that natural gas inventories in the US are still 15% below average, prolonged below-average temperatures could drive inventories to dangerously low levels, again prompting a significant price spike. However, given the supply situation, we believe that any price spike would be short-lived, not dissimilar to the price spike we saw in November.

Pronounced weakness also occurred in base metal prices. Because of continued talk of Fed tightening, renewed dollar strength, and Trump-related trade war anxiety, the base metal complex, which started to pull back in Q3, continued its pullback into Q4. Copper prices fell 6%, zinc prices fell 7%, aluminum prices fell 11%, and nickel prices fell 15%. Copper continues to be our favorite base metal. Since peaking at $3.30 per lb. in June of this year, copper prices have pulled back 20%. Although much has been written about the slowing Chinese economy, according to the World Bureau of Metal Statistics (WBMS), Chinese copper consumption for the first 10 months of 2018 grew almost 6%, a significant acceleration compared to lackluster demand in 2015, 2016, and 2017. Also, after several years of meager, we believe we are beginning to see the first signs of strong copper demand growth coming from India. In previous letters, we outlined how India is making a huge push to electrify the country and that we should expect to see a significant acceleration in Indian copper demand in the next several years. Also global copper exchange inventories continue to fall, indicating to us that the copper market remains in deficit. On the supply side, global copper mine supply continues to stagnate. Over the last three years, we have repeatedly stressed how copper mine supply was going to stagnate after growing strongly in 2015 and 2016 and our modelling has been confirmed by mine data. According to WBMS, global copper mine supply (as reported on monthly basis) has shown no growth over the last two and a half years. Our models also tell us to expect little copper mine supply growth as we move into the next decade. With the prospect of extremely strong demand and little if any mine supply growth, we remain bullish towards copper and continue to recommend significant investment exposure to copper equities.

Precious metals provided one of the few bright spots in global natural resource markets in Q4. After pulling back significantly in the third quarter and producing bearish sentiment levels not seen in 16 years, precious metal prices rebounded. Gold prices advanced 7%, silver advanced 6%, platinum fell 3%, while palladium continued to benefit from the potential ban on diesel engines in Europe. (Platinum is the preferred platinum group metal [PGM] used in diesel engine catalytic converters and palladium is the favored PGM for gasoline powered cars.) Palladium rose a strong 17%. Responding to the rising gold price, gold stocks were strong in Q4. For example, the GDX gold stock ETF rose a strong 15% during the quarter.

Our viewpoint towards precious metals markets has not changed since last quarter. Although we believe a huge bull market in precious metals sits squarely in front of us, we expect the corrective phase in precious metals prices, in effect since the beginning in 2016, to persist. Giving us some confidence in this outlook is the price action between gold and oil. We believe there is a long-term relationship between the price of oil and gold. When gold gets expensive relative to oil, an ounce of gold will buy 30 barrels of oil; when gold get cheap relative to oil, an ounce of gold will buy 10 barrels. This ratio peaked back in February of 2016 when an ounce of gold bought 44 barrels of oil—the highest level ever in the 160 years of data that we keep. Since then oil has been outperforming gold and the ratio has been contracting. In the first week of October, with WTI oil prices hitting $76/barrel and Brent prices hitting $86, the ratio had fallen to approximately 16 and 14, respectively. Although still far away for the extreme low levels we saw multiple times 20 years ago (the ratio fell as low as 7), the ratio had fallen enough to suggest gold was ready for a rally, which happened in Q4. However, with gold firming in price and the price of oil pulling back sharply, the gold-oil ratio surged back up to 30 at the end of December. This suggests to us that oil will be the superior performing asset class in 2019. The upcoming "Precious Metal" section discusses the gold-silver ratio and what it is telling us about the upcoming precious metal bull market. For long-term investors, we recommend using any price weakness to accumulate significant positions in physical gold and silver. As we discussed in our last letter, we received a strong long-term buy signal back in Q2 when speculators went net short both silver and gold and commercials went net long on the COMEX. Although the speculators' short positions and the commercials' long positions do not necessarily mean the bear market in precious metals is over, it does mean that tremendous value has emerged in the market for both these metals. (For those interested in that discussion, please refer back to last quarter's letter.)

Despite the escalation of trade-war rhetoric in Q4, grain markets were unexpectedly quiet. US corn production for the 2018 season turned out to be the second highest on record—yields are estimated to have hit 178.9 bushels per acre—a new all-time record high. US soybean production hit a record 4.6 billion bushels and estimated yields were 52.1 bushels per acre, which rivaled 2016's record yield. The latest World Agricultural Supply and Demand Estimate (WASDE) report issued in mid-December, portrayed a neutral inventory and price outlook for corn, soybean, and wheat.

Because of excellent global weather conditions over the last five years, the world has enjoyed rising yields and record breaking harvests (except for the North American drought in 2012). However, because of changing meteorological cycles, we believe that global weather conditions are about to become much more challenging as we progress into next decade. Although quite controversial, evidence is emerging that we will see a long period of reduced sun-spot activity that will produce global weather conditions that could disrupt the near uninterrupted progression of ever-increasing harvests. In fact, if history is any guide, it's highly probable we could see multiple years of extreme adverse growing conditions in the next 10 years. Given the incredibly strong growth in global grain demand in the last 10 years, any crop disruption could have a huge upward impact on grain prices.

Next quarter's letter will discuss at length the upcoming change in sunspot cycles that seems to be taking place as we write. Sunspot activity peaked back in 2014 and has been in rapid decline in the last several years. Increasing amounts of data suggest that we are entering a period called a Grand Solar Cycle Minimum. If this turns out to be true, we should expect global temperatures to cool in the coming decade and for disruptive weather patterns to become more numerous and severe. The ever-increasing "bin-busting" harvests, so common-place over the last 10 years, will come to end. Because effects from changing weather patterns could very well make themselves felt in the 2019 North American hemisphere growing season, we believe the corrective trading pattern of grain prices over the last several years will be resolved to the upside, and we continue to believe investors should have exposure to agricultural-related equites.

Spot uranium prices were another highlight in global natural resource markets during Q4. As you will recall, Cameco and Kazatomprom both announced supply curtailments earlier in the year at their respective world-class operations. We have often explained how we look to become involved in markets where the commodity price is so depressed that even the best projects in the world generate little to no profitability, and global uranium markets are a perfect example of such a market.

In our last letter, we explained how Cameco would be forced to enter the spot market to meet long-term obligations, given its production curtailment from the McArthur River mine. We argued how these purchases would shed some light into the otherwise opaque uranium market. If Cameco's purchases put upward pressure on spot prices, it would suggest that supply and demand balances were tighter than most analysts had modeled (something we believed was the case). As we expected, spot uranium prices advanced by 30% throughout 2018. Moreover, prices remained firm during Q4, with spot prices advancing another 7% sequentially despite the sharp pullback across the rest of the natural resource complex. For Q4, spot prices averaged $28.27 per pound while the long-term price crept higher to an average of $31.50 per pound. Spot prices have now advanced by more than 50% from the bear-market low made in 2016.

Next quarter, we will review and update our uranium outlook for 2019 and beyond, but as of now the bull market in global uranium is playing out as we expected. We also believe that sentiment towards uranium is improving after several years of increasingly bearish psychology. The change is being driven by the realization that renewable energy without a carbon-free back-up source is both cost-prohibitive and not effective. Since 2011, Germany undertook a massive build-out of its renewable generation capacity at the same time as it decommissioned its nuclear fleet. As a result, not only have German electricity prices doubled, but the amount of CO2 today is greater than in 2011. As carbon becomes the most sensitive environmental consideration, we believe that push-back against nuclear power will recede as people begin to understand its importance in a renewable future. In Q4 alone, there were several high-profile opinion pieces written in major newspapers outlining this argument and our sense is that it is beginning to become a part of the "green" zeitgeist. While the ultimate driver of nuclear demand will come from China, India and Saudi Arabia (demand that is not related to worries over climate change), this shift in opinion is decidedly bullish.

Oil Markets: The Implications of Oil Market Action in the Fourth Quarter

Oil and oil-related securities plummeted during Q4, creating massive opportunities and value in the space. WTI prices fell by 38% during the quarter, marking the worst 90-day pullback since January 2015 when Saudi Arabia began waging an aggressive market share war. Brent prices were comparably weak, falling by 35% during the quarter. Oil-related shares were extremely poor performers: the average E&P fell 39% during the quarter and the average oil-service stock by 43%. In many cases, energy stocks fell below the levels reached in February 2016 despite the fact that oil remained 70% higher now than it did then.

In our introduction, we explained how large retracements are not unprecedented in secular oil bull markets. During the quarter, Jim Rogers said that energy is in the midst of a very complicated bottoming pattern. We completely agree and, given our view of the market fundamentals, we expect the next leg in this bull market (which began three years ago) to start as we speak. The volatility has been difficult (although not unprecedented), but for those contrarian investors with long-term investment horizons, the investment value today is exceptional. Most importantly, the sharp price action has obscured the underlying fundamentals and potentially made the looming market deficit even more acute.

"THE VOLATILITY HAS BEEN DIFFICULT (ALTHOUGH NOT UNPRECEDENTED), BUT FOR THOSE CONTRARIAN INVESTORS WITH LONG-TERM INVESTMENT HORIZONS, THE INVESTMENT VALUE TODAY IS EXCEPTIONAL."

As we explained in the introduction of this letter, oil prices collapsed due to a policy mistake among OPEC member countries. In March of 2018, President Trump announced renewed sanctions against Iran that were expected to impact 1.5-2 m b/d of exports. Even the most bearish energy analyst acknowledged these sanctions would draw global inventories to dangerously low levels and, for the first time this cycle, several others joined us in calling for triple-digit oil prices. Prices rose steadily throughout the spring and summer leading Saudi Arabia to join other OPEC countries to increase production and backfill the expected lost Iranian supply. OPEC decided to increase production ahead of the actual Iranian curtailments in order to calm markets that were quickly becoming very worried about a looming shortage. For example, oil refiners increased their summer orders to help pad their stockpiles and mitigate any risks in the fourth quarter, and OPEC member countries agreed to boost exports to meet these requests.

In total, OPEC production increased by 1.1 m b/d between April and November. In an unexpected move in the first week of November, President Trump announced sanction waivers for seven countries representing 75% of Iran's export volumes, effectively rendering the sanctions moot. As a result, the oil market found itself in a slight surplus (which indeed had been the point of OPEC's production boost) and prices crashed. Concerns about looming trade wars and slowing global demand caused investors to panic although, as you will see in a moment, demand has thus far remained very strong. Many analysts pointed to surging US shale production to explain the falling price although, as we will explain, this was likely not the underlying cause of the sell-off.

OPEC member countries (joined by Russia) met in Vienna on December 7th and quickly agreed to cut back production by1.2 m b/d in 2019. Although some analysts have compared these latest output cuts with OPEC's November 2016 emergency quota cuts, nothing could be further from the truth. Remember, in late 2014, Saudi Arabia abandoned its role as swing producer and increased production to 10.5 m b/d in order to gain market share and put pressure on Iran. After the 2014-2015 oil price collapse, Saudi Arabia finally attempted to reclaim its role as swing producer and agreed to curtail production in November 2016 to help rebalance the market. This time around, Saudi Arabia quickly acted in in their role as swing producer, boosting production to balance a market they expected to be in severe deficit. Once they realized this was not the case, Saudi Arabia quickly curtailed production. Based on our models, inventories will now resume their steady draws throughout the rest of the year and prices will resume their advance.

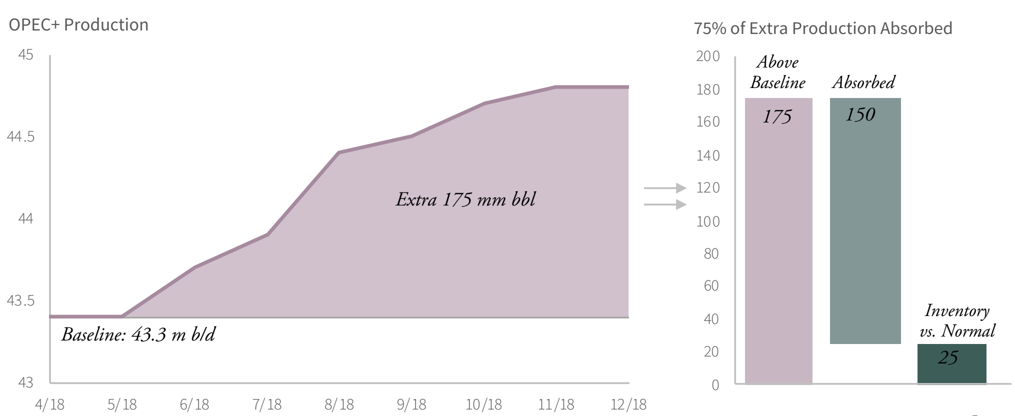
"BASED ON OUR MODELS, INVENTORIES WILL NOW RESUME THEIR STEADY DRAWS THROUGHOUT THE REST OF THE YEAR AND PRICES WILL RESUME THEIR ADVANCE.

While the severe weakness over the past several months has been the result of short-term policy errors, it has hidden many long-term bullish underlying fundamental trends currently taking place in global oil markets, all with potentially large consequences. Now that OPEC has cut production, many of these bullish trends will start to regain importance as global oil markets slip back into deficit.

As we mentioned, many analysts blamed a combination of weak demand and surging shale production for the rise in inventories and price weakness. We strongly disagree with this assessment. Consider that, as of April, OPEC member countries plus Russia (so-called OPEC+) were producing 43.3 mm b/d. Using this as a baseline, OPEC+ increased production1.4 mm b/d by November. In total over that period, we calculate 175 mm barrels were added to global oil markets. Over that same period, global inventories grew by only 25 mm barrels relative to long-term averages. Therefore, without the OPEC+ production increase, inventories would have drawn sharply by150 mm barrels between April and November, or 725,000 b/d. Given that the market was undersupplied by 550,000 b/d in 2017, this suggests that absent OPEC's decision to boost production, the market deficit would have actually accelerated in 2018, even accounting for the stronger than expected production from the US shales. We have long argued that the US shales would continue to grow, and the world oil market would need every barrel it could get. In retrospect, that seems to have been the case.

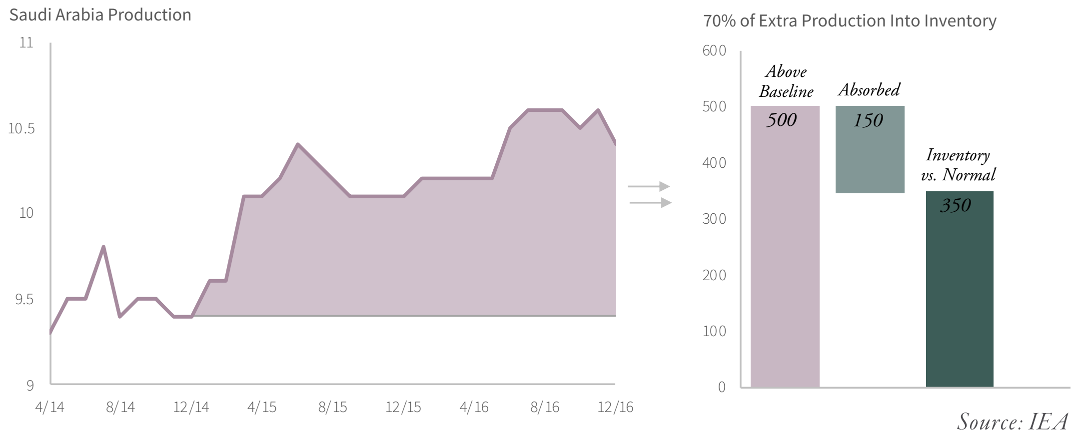
Today's dynamics are materially different than the 2014-2015 experience. In November 2014, Saudi Arabia abandoned its role as swing producer and pumped 9.4 mm b/d. Over the next24 months, it increased production by 1.2mm b/d and added nearly 500 mm barrels to global oil supplies in aggregate. At the same time, global inventory levels rose by 350 mm barrels over that period (mostly in the US). In other words, in 2014-2016, 75% of Saudi Arabia's additional production made its way into inventories, whereas today 75% of OPEC+'s increase was absorbed by the world's oil market. What is keeping oil markets so tight this time despite rising OPEC production? Longtime followers of our research will immediately recognize the two underlying fundamental forces that helped keep oil markets relatively balanced. We expect these forces will become even more severe throughout 2019 and beyond with very bullish results.

CHART 2 OPEC+ Production



Source: IEA

CHART 3 Saudi Arabia Production



Source: IEA

First, non-OPEC oil supply outside of the United States and Russia deteriorated materially over the past six months. In our Q2 2018 letter we explained how conventional non-OPEC oil supply was at risk of disappointing. Over the past decade, conventional non-OPEC discoveries totaled up to 110 bn barrels while consumption equaled 360 bn barrels. We have long argued that the dearth of conventional discoveries would soon result in declining non-OPEC production outside of the US and, as outlined in last quarter's letter, we believe this is now taking place. As we mentioned in the introduction, during Q4, the head of the IEA, Dr. Fatih Birol, stated under-investment in conventional non-OPEC production would be the dominant force affecting global oil markets in coming years.

The one non-OPEC country currently bucking this trend is Russia. Over the last nine months Russian oil production has increased by a material 450,000 b/d. We have traveled to Russia many times over the last 20 years and in the past we have written in-depth on their oil production potential. We are in the process of undertaking a large research project on the Russian oil industry and will present our findings in our next quarterly letter. In the meantime, Russia has agreed to curtail production in 2019 in conjunction with the OPEC agreement made in November and so for the immediate term we do not expect Russian production to grow further.

While Russia has been a bright spot in conventional non-OPEC production, it has masked the intense deterioration in the rest of the world. Outside of Russia, we estimate that conventional non-OPEC oil supply declined by 1.0 m b/d between July and December. In particular, the North Sea, Mexico and Brazil all disappointed and we expect this to continue going forward. Although we have been commenting on the strains in conventional non-OPEC production for quite a while, these shortfalls have largely taken the market by surprise. When they first released their 2018 supply estimates in the summer of 2017, the IEA (which forms the basis for most energy analysts' models) called for non-OPEC oil supply ex the US and Russia to grow by 600m b/din 2018. This figure has now been revised down by 65% to 200,000 b/d but our models tell us that more revisions may be forthcoming.

Despite spreading weakness in conventional non-OPEC production, the IEA still expects growth in 2019. In their most recent report, the IEA expects non-OPEC production outside of the US and Russia will grow by 125,000 b/d. Our models tell us this will not be possible given the lack of new large-scale projects slated to come online next year (for an in-depth analysis please see our letter from July 2018). In particular, the IEA expects Brazilian offshore production to solve the complex technical issues that have impaired their production over the last five years. While it is true that five new floating production storage and offloading (FPSO) vessels are scheduled to make their way to Brazilian waters this year, our analysis suggests that geological issues in the Campos and Lula (formerly Tupi) ultra-deep-water fields are largely to blame for the recent production disappointments. In particular, the Campos wells are declining faster than expected while the Lula development is producing considerably higher water-cuts than anticipated. These problems are not easily solved and as a result we expect Brazilian production to once again disappoint in 2019. Similarly, we expect that massive underinvestment in the North Sea and Mexico over the past decade will continue to take its toll on production from these regions. Lastly, in the beginning of December, Canadian lawmakers announced Alberta would curtail its oil production by 325,000 b/d for an extended period. These curtailments now add downward pressure on slowing Canadian production—production already impacted by the lack of new expected project startups going forward. Despite these announcements, the IEA is still calling for Canadian production to be flat in 2019. We believe this is impossible.

"LOOKING FORWARD, WE STILL THINK THE IEA IS ONCE AGAIN FAR TOO OPTIMISTIC REGARDING ITS 2019 ESTIMATES FOR NON-OPEC PRODUCTION OUTSIDE OF THE US AND RUSSIA. INSTEAD OF GROWING BY 120,000 MB/D, OUR MODELS TELL US IT MAY ACTUALLY DECLINE BY 300,000 B/D."

Last year at this time, the IEA had expected 2018 production would grow by 650,000 mb/d, a figure we strongly disagreed with at the time and which has since been revised lower by 67%. Looking forward, we still think the IEA is once again far too optimistic regarding its 2019 estimates for non-OPEC production outside of the US and Russia. Instead of growing by 120,000 mb/d, our models tell us it may actually decline by 300,000 b/d.

The other fundamental factor keeping global oil markets tighter than expected during 2018 was very strong demand. The IEA states that 2018 demand averaged 99.3 mb/d, an increase of 1.3 m b/d compared with 2017.However, we believe this needs to be revised materially higher. The reason continues to be the so-called "missing barrels," which have now averaged over 1.0 m b/d over the last six months. These "missing barrels" represent oil that has been produced but (according to the IEA) neither consumed nor placed in inventory. We have long argued that these missing barrels represent underestimated non-OECD demand (particularly from India and China), based on our emerging market S-Curve demand models. With data now in through November, the IEA estimates that global demand averaged 99.2 m b/d in 2018 while supply averaged 99.9 mm b/d. This would suggest that global inventories should have grown by 700,000 b/d or 240 mm bbl in total throughout the year. Instead, inventories only rose by 70 mm through November. This suggests that global demand as understated by as much as 500,000 b/d and that actual growth averaged an incredibly strong 1.8 mb/d for 2018. Given that these "missing barrels" have been accelerating in recent months, we expect they will continue into 2019, further tightening global oil balances.

The final key driver of global balances in 2018 was the strong performance from the US shale basins. Our long-held view is that the Permian basin still has ample room for strong growth while the Bakken and Eagle Ford are experiencing their first stages of field depletion. In retrospect, we under-estimated the production potential of all three basins in 2018. When we make our predictions, we rely heavily on so-called "road maps." In these letters we often describe both our projections and the various "mile markers" we need to pass if indeed our models are correct. If our projections are wrong, we can go back to these "mile markers" to determine where our models need correction. In our Q1 2018 letter, we explained the three factors we believed were impacting production from the Bakken and Eagle Ford. Longer lateral length and increased proppant loading were increasing per well productivity while the move from high-quality drilling locations to lower-quality ones was hurting productivity. Given the fact that oil-service and E&P companies were pointing to limits in both drilling length and proppant loadings, we argued that the move from Tier 1 to Tier 2 drilling locations would become the main driver in future drilling productivity and as a result lead to slowing and ultimately declining production in the Eagle Ford and Bakken sometime in 2018. In retrospect this was incorrect as both of those basins exhibited strong production growth throughout the year.

Turning to our "mile markers" we can see where we went wrong and how best to update our projections going forward. In our earlier letter, we said how the move from a Tier 1 well to a Tier 2 well should result in a 50% productivity decrease per lateral foot drilled given constant proppant loading. Moreover, a 100% increase in proppant loading should result in a 50% increase in productivity per lateral foot according to our industry sources. Between 2013 and 2017, proppant loading per lateral foot increased by 150% in the Bakken and by 70% in the Eagle Ford. Over that same period, productivity per lateral foot only increased by 50% and 17% in the Bakken and Eagle Ford, respectively. Using our rough calculations, this implied that drilling in the Bakken went from all Tier 1 locations in 2013 to 30% Tier 2 locations by 2017. Similarly, this suggested that the Eagle Ford went from 100% Tier 1 wells to 25% Tier 2 wells between 2013 and 2017. Looking forward, we estimated that if proppant loadings per lateral foot stayed constant and the migration to lower-quality wells continued then productivity per well would decline by 15% and both basins would see production roll over sometime in 2018.

Instead the Bakken grew by 200,000 b/d and the Eagle Ford grew by 115,000 b/d. Where did we go wrong and how can we adjust going forward? First, we had expected that lateral length and proppant loadings would remain constant but instead both factors saw modest year-on-year increases. In the Bakken, average lateral length increased by 2% while proppant loading per lateral foot increased by 4%. In the Eagle Ford, the average lateral length increased by 4% while proppant loading per lateral foot increased by 7%. While it was clearly a mistake to assume constant lateral length and proppant loadings, we should point out that 2018 represented a massive deceleration compared with prior years. For example, between 2015 and 2017, proppant loading in the Bakken grew by 34% per year or 10 times the growth in 2018. In the Eagle Ford, proppant loadings grew nearly 20% per year between 2015 and 2017 or three times the growth in 2018. Therefore, we believe that we were simply early in calling for constant lateral lengths and proppant loadings. If we are correct, then the impact of the migration from Tier 1 to Tier 2 wells may simply be pushed out to this year. For example, production per new well in 2018 grew by less than 1% despite the fact that average lateral length was 4% greater and proppant loadings were 7% higher year-on-year. While the Bakken performed slightly better, both plays are still showing early signs of exhaustion. Our models suggest that we have now gone from drilling 100% Tier 1 wells in both the Eagle Ford and Bakken to 50% and 30% Tier 2 wells in each play, respectively.

"IN ORDER TO 'MINIMIZE OUR TRAVELLING TIME DOWN THE WRONG ROAD,' WE AIM TO HAVE A FRAMEWORK IN PLACE THAT ALLOWS US TO REALIZE WHEN WE ARE NOT PASSING OUR "MILE MARKERS" AND ADJUST ACCORDINGLY."

The other drivers of unanticipated growth last year were a combination of a higher-than-expected rig count and an increase in monthly completions per rig. Recent data suggests that lower oil prices are having a strong impact on the rig count in the US, which declined by 22 rigs last week alone, while monthly completions per rig shows signs of stabilizing. We admit that these factors are often the most difficult to model and we will monitor them very closely. However, if we are correct then the migration from Tier 1 to Tier 2 wells will be the most important driver going forward. Looking into the future involves uncertainty and we have always admitted there are often things we miss and/or get wrong. In order to "minimize our travelling time down the wrong road," we aim to have a framework in place that allows us to realize when we are not passing our "mile markers" and adjust accordingly.

Regarding drilling productivity from the Permian basin, very interesting data continues to emerge. We have long argued that the Permian would continue to grow materially over the next several years, but that this growth would be needed to balance strong demand and meet disappointments in conventional non-OPEC production. The relatively benign level of inventory builds throughout 2018 despite stronger-than-expected Permian growth increases our faith in this conviction. However, we think we could be seeing the first signs of field exhaustion on the Midland side of the Permian. For example, between 2013 and 2017, productivity per lateral foot in the Permian grew materially by 20% compounded per year. In 2018 this growth slowed to 3%. Moreover, comments from oil-field service leader Schlumberger during their third quarter conference call alluded to disappointing results in so-called "child wells" in the Permian. "Parent" wells refer to the first well drilled on a pad in a virgin section of land, while "child" wells simply refer to the subsequent wells drilled. The fact that the "child" wells were experiencing performance degradation of as much as 30% compared with the parent wells suggests that the wells are "communicating" with each other, which is a sign a field is progressing into its middle-life phase of development. During the quarter, Bradley Olsen of The Wall Street Journal published an article indicating that many E&P companies were overstating their well results in their corporate presentations. While both of these comments are anecdotal, we think they drive home the point that the shales, while incredibly impressive, are ultimately finite in nature and will suffer exhaustion much the same as any other hydrocarbon resource.

"IF WE ARE CORRECT, THIS WOULD TAKE OECD INVENTORY LEVELS TO 4.2 BN BBL BY THE END OF 2019 OR 90 MM BBL BELOW THE TEN-YEAR AVERAGE LEVEL – A RECORD DEFICIT."

Looking forward to 2019, we believe the oil market will once again slip into structural deficit and inventories will decline materially as we progress through the year. In their latest report, the IEA projects 2019 year-on-year global oil demand growth of 1.4 mm b/d to reach 100.6 mm b/d. As we discussed earlier, our missing barrel analysis continues to point to forthcoming upward revision to 2018 demand of as much as 500,000 m b/d. We believe these missing barrels are actually demand underestimation, and we expect this underestimation of demand to continue into 2019. As a result, we believe global demand projections for 2019 are understated by 500,000 m b/d and will ultimately reach 101.1m/bd. Please remember that the IEA has now revised its demand projections higher in seven of the last eight year by 1.2 mm b/d on average. We don't expect 2019 to be different. While concerns about trade wars and economic slowdowns are widespread, we should point out we have seen no impact to date in global oil demand figures. Non-OPEC production outside of the US and Russia, according to the IEA, is expected to reverse course and grow by 120,000 b/d in 2019—a number we believe is simply not possible. Instead, given the severe recent weakness in this group, we believe this number may actually decline by 300,000 b/d in 2019 to reach 40.1mm /bd. Russia has announced they will curtail production by 400,000 b/d from their November levels, resulting in full-year production of 11.4 mm b/d for 2019. The IEA is projecting US production to grow by 1.3 m b/d in 2019 and here our models actually suggest growth may be understated. Assuming the US is able to grow by 1.5 m b/d on a year-on-year basis, production would average 16.9 mb/d in 2019. Adding in biofuels, refining gains, and OPEC NGLs, we expect total non-OPEC production in 2019 to average 68.4 mm b/d. Given demand of 101.1 mm b/d this implies a call-on-OPEC of 32.7 mm b/d. At their November meeting, the cartel agreed to a cut of 800,000 b/d that would leave 2019 OPEC production at 32.2 mm b/d, suggesting an oil market deficit of 500,000 m b/d for 2019. If we are correct, this would take OECD inventory levels to 4.2 bn bbl by the end of 2019 or 90 mm bbl below the ten-year average level – a record deficit. While OPEC may increase quotas at their April 2019 meeting, our models tell us this will in fact be necessary to avoid a drastic decline in global oil inventory levels and a spike in prices.

Before we finish, we would like to comment on the January 2019 announcement of Saudi Aramco's reserve report. Beginning in the fall of 2017, we have argued that the Aramco IPO would be hindered by the required regulatory disclosure regarding the size of their oil reserves. Aramco's reserve reports are a closely held state secret and the last published report dates to 1979. Throughout the 1980s, we believe Aramco reclassified its probable reserves into proved reserves and since then they have held this reported level flat at 260 bn bbl despite having produced over 110 bn bbl during that period. We have long argued that the size of the Saudi reserves is much closer to 160 bn bbl than their stated amount of 260 bn bbl and that this discrepancy would ultimately make a public listing on a major exchange impossible. When Aramco indefinitely postponed their listing in 2018, we took this as a major indication our analysis was correct. Then, in a surprise move in January, Aramco announced that DeGolyer MacNoughton had completed the first new audited reserve report in 40 years, confirming their proved oil reserves were in excess of 263 bn bbl. DeGolyer MacNoughton is a very reputable reserve engineering firm based in Houston whose founding member was actually involved with the original Saudi Arabian oil surveys in the 1940s.

While the reserve report is a major announcement from Aramco, it invites as many questions as it answers. Until the full report is released (and it remains unclear that it ever will be), we cannot answer the crucial question surrounding reserve reconciliation: How was Aramco able to increase its reserves over the last thirty years despite having produced over 100 bn bbl during that time? Without access to the full audited reserve report, it is impossible to say for certain. In the meantime, we can speculate. Intuitively, the two sources of reserve additions are new field discoveries and improved recovery factors from existing fields. The last major fields to be put into production in the Kingdom were the Khurais and Manifa fields, both of which were discovered in the 1950s – the last era of major new discoveries. Since then, both the size and number of new field discoveries have slowed sharply. While it is possible that a major new discovery was made over the last thirty years, the likelihood (and strategic motivation by Aramco) that this occurred without anyone finding out is extremely low. Instead, any new field discoveries have likely come from small oil pools. Some statistical techniques can be used to estimate additional "undiscovered" oil resources. While we do not have time to go into them any detail, several industry papers from thirty years ago have alluded to 30 bn bbl of total undiscovered oil resources, mainly coming from a multitude of smaller pools. The other source of reserve additions is improved recovery factors. Back in 1979, total Saudi Arabian oil-in-place figures were approximately 530 bn barrels (a number which appears in various reports many times). At the time, proved reserves were pegged at 110 bn bbl suggesting a recovery factor of 20%. At the time, this figure was in line with both the US average recovery factor of 23% and consistent with the assumed limit of a field producing from solution-gas drive. Since then, secondary recovery (in which water is injected into the reservoir) and tertiary recovery (in which gas is injected into the reservoir) have steadily increased recovery factors. Based on the latest technology, 70-80% recovery factors are possible under ideal situations using both secondary and tertiary recovery techniques.

Using the 530 bn bbl original oil-in-place figure as a starting point and adding 30 bn bbl of additional resource from recent small-field discoveries results in 560 bn bbl of original oil in place. Given that Saudi Arabia has produced 160 bn bbl from its fields and still has 270 bn bbl remaining, suggests that a total of 430 bn bbl of the 560 bn bbl original oil in place will be produced, implying a recovery factor of77%. In other words, absent a major new field discovery, it seems unlikely that the Saudi reserve figures will be able to overcome field depletion going forward. In our last letter, we profiled Dr. King Hubbert, a Shell geologist whose prediction in 1956 that US conventional oil production would peak in 1970 (which it then did) made him famous. His analysis, although very controversial, suggests that a hydrocarbon system will experience peak production when 50% of its recoverable reserves have been produced. Our analysis, as of today, suggests Saudi Arabia has produced 160 bn bbl of its 430 bn bbl of ultimate recoverable reserves, or nearly 40%. If Saudi Arabia produces at 10.5 mm b/d, it would hit the 50% mark in approximately 14 years. After this point, according to the Hubbert curve, production would enter its period of structural decline. We should point out that Aramco's full reserve report has not yet been released and, on the surface, seems to be very optimistic. Peak production could likey occur sooner. However, even taking the headline at face value suggests that recovery factors are likely approaching industry-record levels. With these most optimistic assumptions, we appear to be quickly approaching the 50% level in produced recoverable reserves after which it will be increasingly difficult (and expensive) for Aramco to maintain production. We provide this analysis as a "best case" bookend scenario and would like to stress that, until we see the full reserve report, we feel that the risk to the proved reserve number is to the downside, with bullish consequences for world oil markets.

The massive sell-off in oil and oil-related securities during Q4 has created unprecedented value in the space today. For example, using a $75 long-term oil price deck, we estimate that many companies today in high-quality areas of the Permian basin are trading below one-times their proved reserve PV-10 value. This suggests that any additional reserves other than those in the current five-year development plan hold no value. Given the fact that the Permian basin is the only bright spot in non-OPEC oil production globally, there is a fundamental problem with their valuations: were the Permian to stop developing its reserves, oil prices would be far in excess of $75 per barrel. These opportunities seldom present themselves, but when they do they carry the potential for exceptional future returns. Given the bullish fundamentals in 2019 and beyond and the irrational valuations of many energy companies, we continue to believe oil-related investments represent tremendous value.

North American Natural Gas: Weather-Related Imbalances Emerge

Henry Hub gas prices were volatile during the quarter, spiking as high as $4.93 per mmbtu before settling back and ending the quarter at $2.94. Weather was the dominant theme during Q4 as a colder than normal start to the North American winter heating season increased demand and led to an above-average draw in inventory levels.

In previous letters we've laid out our cautious stance on North American natural gas, due to record levels of production growth. The development of the Marcellus and Utica shales, along with the associated gas produced in the Permian and SCOOP/Stack shale oil plays has resulted in a truly impressive, abundant supply of natural gas. While demand has been very strong in the US, driven by increased use in electricity generation, LNG exports, and new petrochemical facilities, it has not and will not be enough to absorb the huge year-on-year growth coming from the sources we just described. For example, while five bcf/d of new LNG demand is expected to come online in 2019, dry gas production grew by over 10.1 bcf/d year-on-year in October and is accelerating. For the first ten months of 2018, natural gas supply grew by 8.4 bcf/d – nearly twice the previous record set in 2014. Furthermore, this record growth was achieved with a rig-count that averaged only 189 gas rigs (~50% below the same period in 2014). This leaves the North American market susceptible to even a modest increase in drilling activity.

"WHILE ANY WEATHER-RELATED PRICE SPIKE IS LIKELY TO BE SHORT-LIVED, THE RISK/RETURN NOW EMBEDDED IN CERTAIN SELECT NATURAL GAS SECURITIES HAS BECOME MORE COMPELLING."

Despite the surge in natural gas production, inventories actually drew throughout 2018, driven entirely by weather. April was the coldest on record and resulted in an extra 175 bcf of gas being consumed compared with seasonal averages. This was followed by a 10% hotter-than-average summer that left inventories at 3.4 tcf by November, some 575 bcf below the seasonal-averages and the lowest injection-ending reading since 2003. In our last letter, we explained how despite the bearish supply dynamics in North American natural gas, prices could spike if winter temperatures were colder than expected, and this is exactly what we experienced. November was 15% colder than normal across much of the United States, and we estimate that an additional 115 bcf was burned for heating as a result. Once temperatures normalized in December and January, the supply challenges once again came to the fore and prices retraced all of their previous advance.

With inventories still at 400 bcf below average and the majority of the winter heating season still ahead of us, North American natural gas prices are once again susceptible to a weather-related price spike. At the same time, the energy sell-off during Q4 impacted natural gas-weighted energy stocks nearly as much as their oil-weighted cousins. As a result, some of the highest quality Marcellus producers are now trading below their proved-reserve PV-10 values, even using sub $2.50 natural gas prices. While any weather-related price spike is likely to be short-lived, the risk/return now embedded in certain select natural gas securities has become more compelling.

We should point out that the bullish factors impacting North American natural gas are medium-term in nature, whereas we believe the longer-term supply overhang is more structural in nature. Nevertheless, given the near-term outlook for colder weather for the remainder of January and beginning of February and the depressed valuations of many high-quality gas producers, we are beginning to find some select investments more and more interesting on an opportunistic basis.

Copper Markets: India Begins to See Growth

As we mentioned in our introduction, copper prices were weak during the quarter, falling by 6% over concerns about slowing global economic growth and the effect of trade wars. Copper- related equities were weak as well, with many bellwethers falling by over 20% during the quarter. Despite the weak price action, copper fundamentals remain very strong. Global exchange traded copper inventories (the LME, Comex, and Shanghai Metals Exchange) peaked at 900,000 tonnes in March and have plummeted by 570,000 tonnes or 65% since then to stand at 330,000 tonnes today. Inventory behavior suggests that global copper markets have slipped into sharp deficit. Our models tell us this will only accelerate from here.

In our past letters we have discussed the rising importance of India to global copper markets. Our models consider the total per capita installed stock of copper in an economy and its real GDP per capita. These models accurately predicted that China would progress from 45 lbs installed per person in 2006 to the 175 lbs installed per person today. While we expect Chinese copper demand to continue to grow strongly over the coming decade, we have also commented how India has thus far under-invested in its per capita copper stock given its size. For example, when China was at a comparable level of per-capita GDP, its installed copper base was 45 lbs per person while India today is at 14 lbs.

In any economy, electricity distribution infrastructure is a major source of installed copper. In particular, electrical substations that connect high-tension power lines to individual households utilize

"INDIAN REFINED COPPER DEMAND SURGED BY 13,000 TONNES OR 33% ON A YEAR-OVER-YEAR BASIS TO REACH 50,000 TONNES PER MONTH."

huge spools of copper wire to step-down the electricity and render it useful for consumers and businesses. In our last letter, we explained how Indian Prime Minister Modi had recently announced the fulfillment of a campaign promise to connect every Indian village to the power grid early last year. After returning from our research trip to India last February, we discussed the disconnect between PM Modi's claims and the meager levels of copper installed in the Indian economy. We argued it would be impossible to connect 1.3 billion people to the power grid without a substantial investment in the copper stock. Subsequently, it was revealed that a village was deemed to be "connected" if any government building in the village had electricity. While high-tension power lines (not copper intensive) had been installed throughout India, the number of copper-laden electrical substations remained very low.

We argued that as the Indian government moved to connect individual households, the number of necessary substations would increase dramatically and serve as a catalyst for increased Indian copper demand. Data from the WBMS now suggests this may currently be underway. In October, Indian refined copper demand surged by 13,000 tonnes or 33% on a year-over-year basis to reach 50,000 tonnes per month. The Indian government has recently announced two key goals that could result in much higher copper demand going forward. First, PM Modi announced his goal to have 25 mm Indian homes connected to the power grid by December 31st 2018. Preliminary indications are that most of these homes met the deadline and are now connected. However, the rapid increase in connections has given way to very poor reliability across much of the Indian power grid. According to the World Bank, India ranks 80th out of 137 countries in terms of electrical reliability, despite being the sixth largest economy in the world (and the fastest growing).

Once again, we believe the issue is inadequate investment in the substation infrastructure. If a power grid lacks enough sub-stations for its underlying demand, widespread power outages like those currently experienced across much of India would result. Our hypothesis is consistent with the simultaneous observations that the Indian installed copper stock is low for an economy of its size and that a large number of household connections has resulted in increased widespread outages. The only way for India to fix the latter is to invest in the former – with huge implications for global copper markets.

Now that PM Modi has fulfilled his promise of connecting some 25 mm households that lacked access to the electrical grid, his next target is to provide stable 24/7 electricity to all end users by March 31st 2019. While a laudable goal, it seems like a herculean task in such a short time. Regardless of whether PM Modi achieves his stated goal, it seems clear to us that demand for electrical substations (and, by extension, copper) is set to continue the sharp growth we have seen over the last six months.

How big could this impact be? If India were to achieve only 50% of the installed copper base that China had back in 2006 when real per-capita GDP was at a comparable level, India would require an additional 10 pounds per person. Given India's population of 1.4 bn, this equates to an additional 6 mm tonnes of installed copper. Taking the conservative view that this "catch up" will play out over the next five years suggests that monthly demand will reach 100,000 tonnes per month – nearly double the level seen in October.

While these figures might seem unreasonable, please remember that when China went through this same experience, it grew refined demand from 50,000 tonnes per month to 100,000 tonnes per month in a period of less than a year. Following this jump, Chinese refined-copper demand continued to surge ten-fold in the next 13 years, eventually exceeding 1 mm tonnes per month. If we are approaching a similar inflection point for India (and we think that we are), then global copper inventories will continue drawing down sharply, helping to boost prices.

Given the huge sell-off in copper-related securities, many of them are trading at massive discounts to their net-asset-values given $2.50 copper. Copper remains our favorite theme outside of energy and we think that we are now in the process of a period of strong demand growth.

Precious Metal Markets: What the Gold-Silver Ratio Can Tell Us About Precious Metals

In previous letters, we stated our belief that a huge new bull market would develop in gold that could take the metal to levels significantly higher than today's price. Using several valuation techniques, we outlined how gold was as cheap as it had ever been. For example, priced against financial assets and the amount of Federal Reserve credit outstanding, gold had reached valuation extremes that had only be been reached twice in the last 50 years, in 1970 and again in 1999. In retrospect, we know that both those periods were excellent times to be an aggressive investor in precious metals markets. From a sentiment perspective, we also discussed the significance of the positioning by traders on the COMEX metals exchange. Back in August, speculators on the COMEX metals exchange went net short both in both gold and silver at the same time commercials went net long in both metals. As we discussed in the introduction (and in past letters), this type of positioning only takes place during major bear market bottoms. For example, the last time gold speculators were short and commercials long was back in March of 2001, when gold made its secondary low at $257 per ounce. However, we also stressed in our essay that using the positioning of traders and commercials on the COMEX as a precise timing tool had its drawbacks. For example, speculators went short and commercials long in both gold and silver markets in the beginning of 1997, and yet the bull runs in both markets didn't start for another three and half years. For investors seeking long term value, the positioning of COMEX traders in gold and silver is an extremely useful indicator, but as a precise timing tool, this signal can often be early. However, we believe the positioning of speculators and commercials on the COMEX exchange is telling us the bear market in both silver and gold is drawing to a close.

CHART 4 Gold-Silver Ratio

Source: Bloomberg

Today, we would like to discuss another indicator that has fallen into place that also suggests the eight-year bear market (really, four years of price pullback and now a fourth year of trading sideways) is drawing to a close.

This indicator: the gold-silver ratio—suggests that both precious metals markets represent deep investment value and that a significant bull market move in both metals lies in the not too distant future.

For those unfamiliar with the gold-silver ratio, it is nothing more than the price of gold divided by the price of silver. Ever since the US government ended the dollar gold peg with the dissolving of the Bretton Woods agreement in 1971, the relationship of the price of gold and silver has repeated itself multiple times over the last 50 years.

In gold bull markets, the gold-silver ratio contracts, as the price of silver rises faster than the price of gold. In severe bear markets, the ratio expands, as the price of silver falls faster than the price of gold. Since 1971, there have been five times when the gold-silver ratio has surpassed 80 (when an ounce of gold buys 80 ounces of silver), and in four of those instances, it paid to accumulate significant positions in both metals. Only in 1990, when the gold-silver ratio almost broke 100, did this ratio give off a buy signal that did not result in an ensuing bull market.

The first period when the gold-silver ratio exceeded 80 occurred back in the in Q4 of 1990. It lasted for four years. Silver bottomed in price in February of 1991 at $3.50 per ounce and with gold at $350, and the gold silver ratio hit 100 -- a level that we have never reached again. Although silver made a double bottom in March of 1993, it traded sideways (except for the short-term "Buffet" rally at the end of 1997) until it bottomed at $4.60 in the first quarter of 2003, which you will see is an important date. In retrospect, we know the peaking of the gold-silver ratio in 1991-1993 had no significance to gold. Gold during that time period traded around $350 per ounce and didn't bottom until 1999-2001, at a price almost $100 per ounce lower.

The second time the gold-silver ratio hit 80 was in the March 2003 when silver bottomed at $4.30 per ounce and gold was still at $345 per ounce. In this instance, the gold-ratio hitting 80 gave precious metal investors a great buy signal. Over the next five years, gold advanced 190% (from $345 to $1000) and silver advanced by almost 390% (from $4.30 to $21).

After the 2008 financial crisis, silver prices fell over 55% and gold fell almost 30%. In November 2008, the gold-silver ratio surpassed 80 for the third time and the gold-silver ratio flashed another great buying opportunity. Silver and gold bottomed at $9.20 and $720, respectively, and then proceeded to advance 420% (silver peaked at almost $50) and 160% (gold hit $1,900) in the next three years. In the next four years, gold proceeded to pull back 45% and silver by over 70% and, by the first quarter of 2016, the gold-silver ratio broke 80 again, the fourth time. Silver had a strong advance in 2016 and the gold-silver ratio retraced slightly to 75 by last summer. With silver pulling back to $14 in September and gold rising above $1,200, the silver- gold ratio in November surged above 80 and hit 86 at the beginning of December, the fifth time. Although it's not a perfect indicator, we believe a gold-silver ratio above 80 is another sign that the upcoming bull market in precious metals is drawing closer and closer.

More and more pieces of the bull market puzzle are now falling into place. Many of these indicators, whether they be valuation or sentiment, are now indicating that a huge bull market in precious metals prices will start in the next several years. As of today, the only indicator that continues to suggest that we are still in corrective trading is the ratio of the price of gold to oil. With the big pullback in oil prices and the upward move in oil prices in Q4, the gold-oil ratio hit 30, traditionally a level that indicates oil will spend significant periods of time outperforming gold. Given the extremely high reading of the gold-oil ratio today, we believe that oil today represents a better investment over the next 12 months.

For investors with long-time horizons, we believe they should be accumulating investments in precious metals. For those with performance constraints, the history of the gold-oil ratio suggests that that we are still in the corrective phase of the precious metals market that started back in Q1 of 2016.