Bellwether CONSULTING

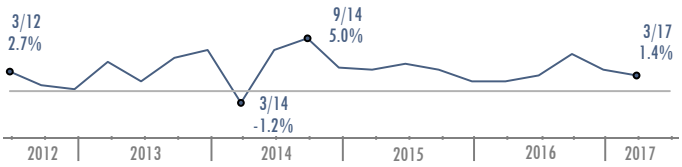
Your Quarterly Update on the Financial Markets
June 30, 2017

MARKET Recap

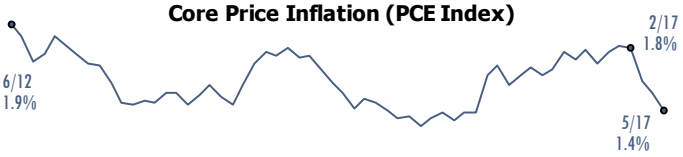
The US Economy: "The New Normalization"

Economic growth continued to slow in the first quarter. The inventory cycle turned negative, with private inventory investment shaving 1.11% off of the annualized growth rate. Personal consumption contributed to growth but at a much slower pace than the prior 3 quarters, with purchases of durable goods and healthcare-related services slumping. Finally, defense spending contracted. Set against this, trade balance activity improved on a modestly weaker US dollar; exports surged relative to the previous quarter while imports (which are subtracted from gross domestic product) decreased. Inflation measures declined after peaking in February, yet various measures of activity remained firm; for example, ISM data for manufacturing and service indicated continued expansion.

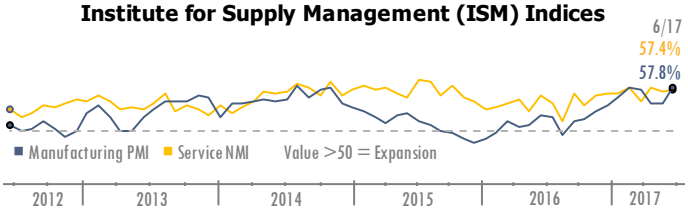
Annualized Real GDP Growth



Core Price Inflation (PCE Index)



Institute for Supply Management (ISM) Indices



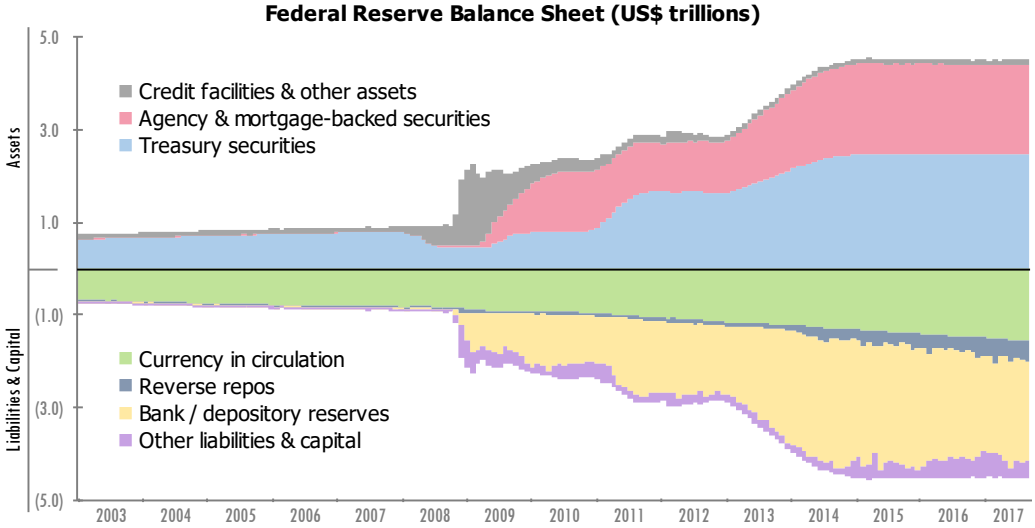
Given the mixed data, what do policymakers do? This quarter the Fed stuck to plan, taking its widely anticipated decision to raise short-term rates on June 14; markets have priced in even odds for one more rate increase this year. Along with the usual presentation materials, they released a short paper titled "Addendum to the Policy Normalization Principles and Plans" in which the FOMC confirmed its intent to gradually reduce its balance sheet assets. They detail a specific plan to phase out their policy of reinvesting proceeds from maturing bonds, ushering in an era of "quantitative tightening."

The Fed's balance sheet ballooned in the aftermath of the 2007-2008 credit crisis, peaking at $4.5 trillion. This unprecedented policy served multiple purposes – providing another form of monetary stimulus by driving down longer-term yields, hoovering up impaired mortgage debt and other toxic assets from bank balance sheets, and restoring confidence in the banking system by creating highly visible excess reserves.

Balance sheet activity is described as a secondary policy tool, but it's of particular interest for pension plans and other investors with long-duration liabilities, as recent curve flattening has frustrated liability-sensitive investment strategies. Minutes from the June FOMC meeting show that members are torn as to when to start the process, with some leaning toward September, and others preferring to wait for additional data. Some expressed interest in slowing the pace of short-term rate hikes once balance sheet normalization begins; others see the two policies as being more independent.

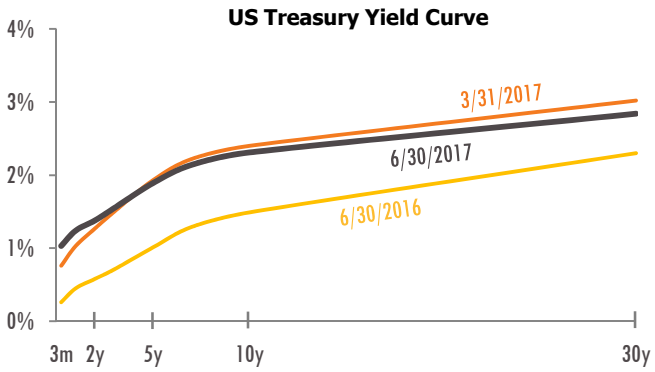
We applaud an overdue return to normalcy in the bond market, but remain curious about the timing given signs of economic activity approaching a cyclical peak. But the pace of tightening will be much slower than the pace of easing, it will end with still-elevated asset levels, and policymakers will halt or reverse course if conditions warrant. Pension sponsors will need to stay patient – the yield drought may finally end, but with a slow drizzle not a flash flood.

Federal Reserve Balance Sheet (US$ trillions)



The US Bond Market

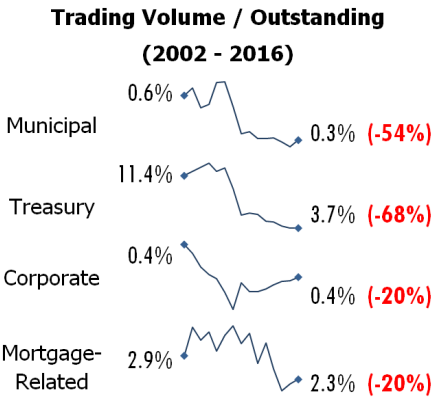
Overnight rates received another bump this quarter as the Fed raised to a range of 1.00% - 1.25%. Yet the quickening pace of rate hikes did not translate to higher rates elsewhere on the curve. Intermediate and longer duration US Treasury yields pulled back, flattening a bit more than in Q1. The benchmark 10-year rate fell 9 bps, ending the quarter at 2.31%. The long bond declined by twice as much to settle at 2.84%. A recent downward trend in inflation has investors less concerned with longer duration interest rate risk. Despite declining nominal yields, the real yield increased by 17 bps on 10-year US TIPS and 6 bps on 30-Year TIPS, for real yields of 0.6% and 1.0% respectively. At the beginning of this year, the market had priced in a total of two rate hikes in 2017. The rate hikes may have happened earlier than forecast, but fed funds futures traders are confident the Fed will not be keeping up with the recent quarterly pace of interest rate moves. As of the second quarter end, the economic data agrees.



US Bond Indices - Total Returns		
Blmbg Barclays	**2Q17**	**YTD**
Aggregate	1.45%	2.27%
Interm. Gov't	0.66%	1.20%
Long Gov't	3.93%	5.44%
TIPS	-0.40%	0.85%
Municipal	1.96%	3.57%
Interm. Credit	1.38%	2.54%
Long Credit	4.70%	6.44%
High Yield	2.17%	4.93%
MBS	0.87%	1.35%

No news was good news for credit spreads, which established a fresh, lower range. High-yield spreads traded within a 20 bps band for most of the quarter, ending right in the middle at 3.77% (BAML US HY OAS). Although not as strong as the 15 bps decline in high-yield spreads, investment-grade spreads narrowed by 9 bps to finish at 1.15% (BAML US Corp. Master OAS). Corporate-bond issuance declined in both investment-grade and high-yield paper, but remained on track to exceed 2016 levels.

In January, the Securities Exchange Commission's (SEC) new rules requiring the establishment of liquidity risk management programs for open-end funds went into effect, with full compliance mandated by December 2018. These rules define clear guidelines for categorizing and reporting the liquidity of securities held by open-end mutual funds and ETFs (excluding money market). Four categories of liquidity range from "highly liquid" securities that can be effectively converted to cash within three business days, to "illiquid investments" that cannot be reasonably expected to sell within seven calendar days without materially affecting market prices. The rules also mandate confidential notification to the SEC if the portfolio weight of "illiquid securities" surpasses 15%. Previously, this threshold existed as a guideline with no action required. The new rules also require funds set discretionary minimums for "highly liquid" allocation. Alongside liquidity reporting, the SEC adopted rules permitting swing pricing on open-end funds (other than money market and ETFs). Swing pricing allows a fund to pass on liquidity costs related to large fund purchases or redemptions directly to the responsible shareholders. Funds may set a maximum "swing factor" of up to 2% that will apply to large purchases or redemptions that exceed a preselected "swing threshold," defined as a percent of net asset value.



While these rules do not target fixed income funds specifically, they are a timely development that may help address a dramatic swing in bond trading volumes by platform, firm, and in total. The shift from telephone to electronic platforms for execution, combined with regulatory changes that restrict proprietary trading and discourage holding bonds on balance sheets have led to Principal Trading Firms (PTFs) displacing the long-held role of broker-dealers as market-makers. Historically, broker-dealers have supported bond markets by providing liquidity, dampening the impact of large trades. For decades, broker-dealers earned attractive profits by brokering transactions between parties, participating in bond auctions, holding securities until they could be placed effectively, and engaging in proprietary trading themselves. PTFs are firmly focused on the latter. They are also unhindered by many of the regulations enacted to help ensure financial market stability and oversight, and may not be required to register with the SEC or FINRA. The shift from market-making to market-matching is more fully detailed in Choi and Huh (2017).

It is difficult to gauge how much downside risk could increase if liquidity has become highly sensitive to volatility. In each of the past three years we have seen portentous, but isolated, flash crashes in US Treasuries, euro-dollars, and (most recently) sterling. A Wall Street Journal survey of the 35 largest bond funds, using data from 2015, measured portfolio

weights of illiquid corporate bonds in those funds with more than 25% corporate credits. Of those 18 funds, illiquid securities comprised as much as 40% of the portfolios. Some fixed income managers purchase illiquid securities without the intent to ever sell them; they are held until maturity, whereupon the proceeds are reinvested. However, in times of crisis, mass redemptions coupled with a sudden drop in market liquidity pose significant cause for concern. Funds most likely to hold a higher percentage of highly illiquid securities are those with high AUM and those investing in lower credit quality, less developed regions, longer duration, or other areas where individual issue sizes are small.

The US Stock Market

The US stock market remained resilient during Q2, shrugging off geopolitical and economic risks. US job and inflation data was notably weak in April. In May, drama surrounding the abrupt firing of FBI Director James Comey and the tight French election race dominated headlines. Ultimately, investors looked past these rising risks and focused on strong growth in corporate earnings which reached 15.3% (YoY), a level not seen since 2011. The number of companies reporting revenue and earnings greater than analyst expectations was well above long-term averages, while 10 out of 11 sectors experienced positive earnings and revenue growth. Although equity market gains were more muted in June, there were significant changes in sector leadership - a large driver of which was the Federal Reserve rate hike mid-month.

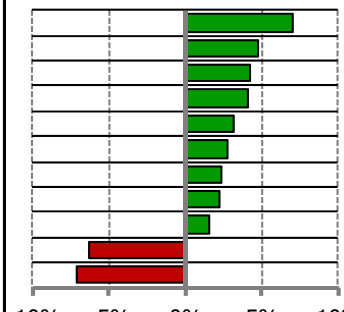
US Stock Indices - Total Returns

Large-cap Stocks	2Q17	YTD	Mid-cap Stocks	2Q17	YTD
S&P 500	3.09%	9.34%	S&P Midcap 400	1.97%	5.99%
Russell 1000	3.06%	9.27%	Russell Midcap	2.70%	7.99%
Growth	4.67%	13.99%	Growth	4.21%	11.40%
Value	1.34%	4.66%	Value	1.37%	5.18%
Broad Markets			**Small-cap Stocks**		
S&P 1500	2.96%	8.87%	S&P Smallcap 600	1.71%	2.79%
Russell 3000	3.02%	8.93%	Russell 2000	2.46%	4.99%
Growth	4.65%	13.69%	Growth	4.39%	9.97%
Value	1.29%	4.32%	Value	0.67%	0.54%

Over the three months, large-cap stocks outperformed their mid- and small-cap counterparts. From a style perspective, growth continued to outperform value on investor demand for technology, health care, and industrial sector stocks. Outside of value and growth, momentum and quality factors were positive while volatility was negative.

Health care stocks outpaced peers in the second quarter, mainly a result of strong performance during June. Biotech companies led the late-quarter rally amid industry-friendly executive order drafts, however all underlying industries but pharmaceuticals contributed to the outperformance. The financial sector shared a similar experience as shares of banks and asset management firms surged in the final weeks of the quarter. Interest rates rose on the back of a Federal Reserve decision to increase the overnight lending rate range, benefitting companies who rely on interest margin to drive profitability.

S&P 1500 Economic Group Components - Total Returns



Sector	2Q17	YTD
Health Care	7.39%	16.47%
Industrials	4.45%	8.85%
Technology	4.09%	16.62%
Financials	3.87%	6.23%
Materials	2.64%	8.55%
Consumer Discr.	2.38%	10.44%
Real Estate	2.35%	5.40%
Utilities	2.03%	8.41%
Consumer Staples	1.34%	7.56%
Telecom	-7.00%	-10.77%
Energy	-7.23%	-13.82%

Source: Standard & Poor's

Within industrials, aerospace & defense companies have been boosted by President Trump's 'Buy American' executive order. Additionally, airlines have earned higher margins due to the combination of industry consolidation, strong travel demand, and low fuel prices. Although technology stocks had a volatile quarter, they ended June as a top performing sector. Much of the volatility came from the hardware, semiconductor, and internet sub-sectors which saw selling pressure on overvaluation concerns. The sector has experienced outsized returns year-to-date, largely attributable to strong earnings growth.

Underperforming sectors included energy and telecommunications. Energy stocks extended their Q1 weakness as the price of oil continued to decline, falling from $50.54 down to $46.02 over the three-month period, a decline of -8.9%. Investors have become skeptical of OPEC's ability to control global supply output with US producers gaining market share despite the commodity's lower price level. The telecom sector also experienced similar results when compared to last quarter, as both Verizon and AT&T reported revenue below estimates. The two market leaders recorded net declines in subscribers (348,000 for AT&T; 289,000 for Verizon), a first ever for Verizon. Smaller wireless carriers like T-Mobile and Sprint have gained significant market share, particularly in markets where they can offer similar quality with cheaper options for unlimited data plans. The June interest rate hike also had a negative effect on the high-yielding sector at quarter-end, in addition to utilities and consumer staples.

Overseas Markets

Foreign markets continued moving higher as investors remained positively disposed to emerging markets during a continued period of relative geopolitical calm. With the beginning of Brexit negotiations, European developed markets also showed surprising strength as accomodative policies continued to pay dividends across the region, including within the peripheral countries. Brexit negotiations began toward the end of the quarter and, while the stakes are high, the final impact and outcome remain unknown.

Foreign Stock & Bond Indices - Total Returns

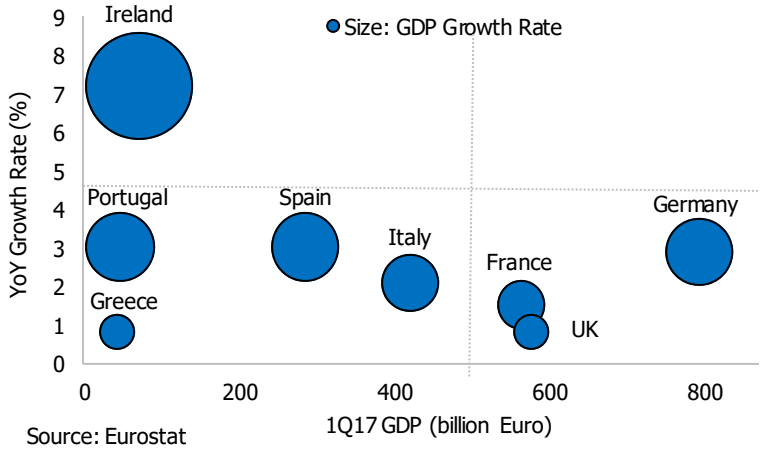
MSCI Broad Indices	2Q 17	YTD	Barcap Global Indices*	2Q 17	YTD
World Index	4.03%	10.66%	Global Aggregate	2.60%	4.41%
EAFE (Developed)	6.12%	13.81%	Pan-Euro	6.25%	7.30%
Emerging Markets	6.27%	18.43%	Asian-Pacific	-0.50%	4.11%
			Eurodollar	1.05%	2.41%
MSCI Regions			Euro-Yen	-0.45%	4.28%
Europe	7.37%	15.36%	Other Currencies	5.70%	15.35%
Japan	5.19%	9.92%	** Unhedged*		
Pacific ex-Japan	1.54%	13.48%			
Latin America	-1.74%	10.12%			

Europe

Eurozone GDP rose to 2.5% in Q1 compared to 1.5% in Q4 '16. Manufacturing grew at its fastest pace for six years in April, according to the purchasing managers' index. The annual inflation rate fell to 1.4% in May, with the biggest drop coming from the energy sector, which decreased to 4.5% in May from 7.6% in April due to lower oil prices. Given its low inflation rate, the Eurozone kept expansionary monetary policy in place at the conclusion of the European Central Bank (ECB) meeting on June 8th. The ECB kept its main interest rate at zero and the rate it pays on bank reserves at -0.4%; it will also continue to purchase bonds ($66bb per month) until at least the end of 2017.

Market pressure on euro area banks waned over the first six months of 2017, with banks' stock prices, in particular, increasing sharply. Low interest rates, however, continue to challenge banks' profitability. In some regions, profitability prospects remain dampened by large holdings of non-performing loans (NPLs). A number of structural challenges also weigh on corporate profits in several banking sectors, including overcapacity, a limited degree of income diversification and cost-inefficiencies. Continued political uncertainty and potentially higher bond yields could trigger higher funding costs and renewed debt sustainability concerns. These vulnerabilities are closely linked to the risk of an abrupt repricing in bond markets.

Eurogroup 1Q17 GDP & YoY Growth



Source: Eurostat

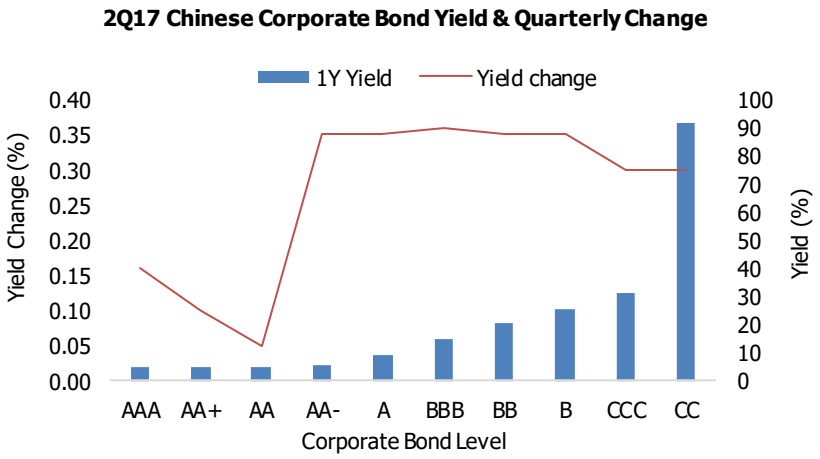
Theresa May began negotiations for the UK's exit from the EU. Brexit is expected to be a negative shock to the UK economy, with fallout affecting other European countries. The UK is likely to suffer from the loss of unrestricted access to the Single Market. It would also face new barriers in many of the third-country markets to which preferential access was lost as a result of exiting the EU, even if it succeeded in negotiating a new trade arrangement with Europe. The risk is that capital inflows would be disrupted, possibly leading to a jarring contraction of the UK's record-high current account deficit of 7% of GDP. It is estimated that by 2020, GDP would be about 3% smaller than if the UK remained an EU member, equivalent to a cost per household of £2,200 (in today's prices). Longer term, structural impacts would affect channels of capital, immigration and technical progress. Labor productivity would be held back by a drop in foreign direct investment and a smaller pool of skilled labor. The cost of foregone GDP would increase over time. By 2030, a moderate scenario estimates that GDP would be over 5% lower than otherwise – with the cost of Brexit equivalent to £3,200 per household (in today's prices). The effects would be even larger in a more pessimistic scenario. Brexit would also hold back GDP in other European economies, particularly in the near term, resulting from the heightened uncertainty.

Emmanuel Macron, founder of the center-left party En Marché, won the 2017 French election in May. Post-election, market confidence has increased and the bund premium has remained elevated. President Macron has argued that labor reforms, lower corporate taxes, reduced public spending and a deep reduction of the civil service are essential to stoke the economy and persuade employers to hire more young workers. The En Marché party made large inroads in parliamentary elections, significantly improving the chances Macron's agenda will be enacted. In the first quarter of 2017, wage growth in France grew at its fastest pace in three years.

Portugal's economy has gone through a gradual recovery from a deep recession. A wide-ranging structural reform agenda has supported this recovery and the ongoing reduction of imbalances built up in the past. However, investment is expected to remain weak against the backdrop of contracting credit and bottlenecks in the implementation of structural reforms to improve the business climate. Unemployment has been declining, but it remains at the uncomfortably high level of 10.5%. A positive outlook from Fitch may pave the way to an upgrade of the Portuguese Republic to investment grade. In late June, the Eurogroup concluded that the Greek economy is entering a period of stability. Simultaneously, Moody's upgraded Greece's sovereign bond rating to Caa2 and changed its outlook to positive.

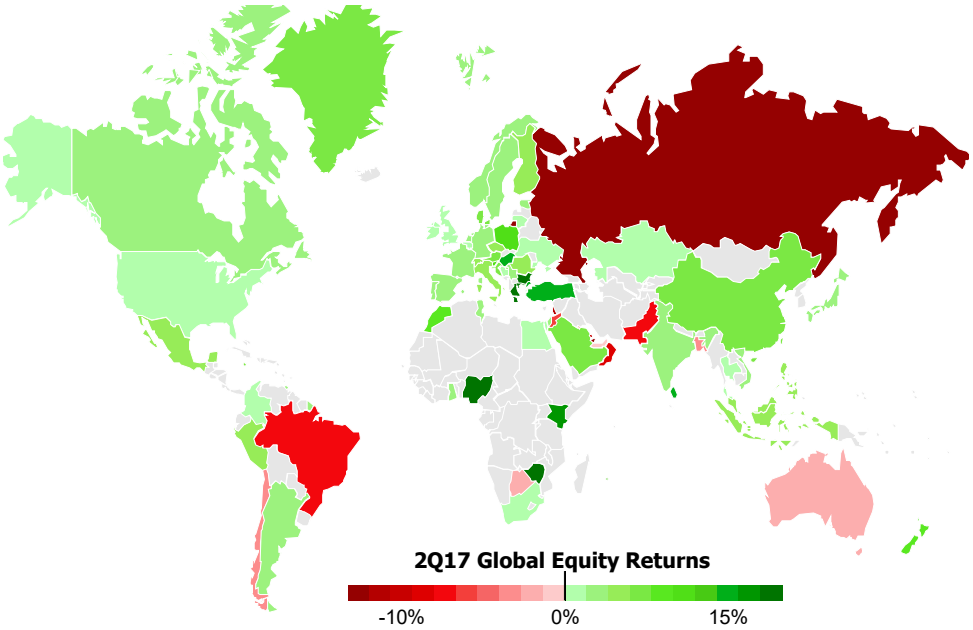
Asia

The IMF increased its forecast of China's GDP to 6.7% from 6.6%, but predicts it will fall to 6.4% between 2018 and 2020. Given the 6.9% level in Q1, GDP is expected to decrease for the rest of the year with projections showing 6.8% for the second quarter and 6.6% for the third and fourth quarters. The yuan remains under control, with the unilateral decreasing trend relative to US dollars having ended. Chinese corporate credit spreads increase during the period.



The biggest uncertainty for the Chinese economy this year is exports, which have recovered slightly in Q2 due to the price increases of large commodities. In March, China initiated the 'One Belt, One Road' policy, promising more than $1 trillion in infrastructure, spanning more than 60 countries, deploying hundreds of billions of dollars of state-backed loans without requiring any military obligation. This approach will strengthen China's burgeoning global influence by pushing global trade. Through investing in the infrastructure of other developing countries, China seeks to solve its overcapacity problem for steel, cement and machinery. Many countries in the program have serious needs. The Asian Development Bank estimated that emerging Asian economies need $1.7 trillion per year in infrastructure to maintain growth, tackle poverty and respond to climate change. It will bring new trade routes and better connectivity to Asia and Europe. However, many of the developing countries participating in this plan have low credit ratings (below investment grade), low GDP, unstable economies, poor public governance, political instability and corruption. It is possible that a number of those countries would default, hurting the plan's profitability in the short-term.

Japan's economy grew less than the government initially reported in the first quarter, weighed down by a drop in inventories of oil and other raw materials and a downward revision to private consumption. However, a weak currency and healthy global demand are propping up economic activity in the world's third-largest economy. But, limited wage growth, uncertainty regarding economic policies in the United States and a sizeable slowdown in China could derail a nascent economic recovery.



The Bank of Japan held monetary policy steady in its June board review, pledging to keep asset purchases around the current target of ¥80 trillion ($727 billion) and sounding more upbeat on the economy. The BOJ raised its economic assessment, increasing its real GDP growth forecast for the 2017-18 fiscal year to 1.6% from the 1.5% projected in January. However, it lowered its core

consumer price index (CPI) growth forecast to 1.4% from 1.5% in the same period. The central bank has been pursuing a yield-curve control policy, introduced at its 3Q16 meeting. The BOJ had set its target yield for the benchmark 10-year Japanese government bond at around zero percent, and it has been willing to intervene to keep the benchmark yield in line with its target.

Mr. Kuroda emphasized the need for the bank to keep pushing ahead with its aggressive measures until Japan's economy clearly escapes more than a decade of deflation and has stable 2% inflation. He said that based on his forecast, the BOJ will likely keep expanding Japan's monetary base even beyond March 2019.

Latin America

Brazil's inflation continued to drop in May, falling to a decade low of 3.6%. The result was below market expectations at the lower end of the Central Bank's target range of 4.5% +/- 2.0%. The sharp fall potentially gives the Central Bank space to continue with its easing cycle to support an economic recovery. One factor that could jeopardize the recovery is the announcement of the US Department of Agriculture's immediate suspension of fresh beef imports from Brazil in June. The announcement was made after inspections uncovered public health concerns, unsanitary conditions and animal health issues. The US is the 9th biggest market for Brazilian beef exports and the 7th region to ban imports of the beef behind China, Mexico, Chile, Japan, the European Union and Hong Kong.

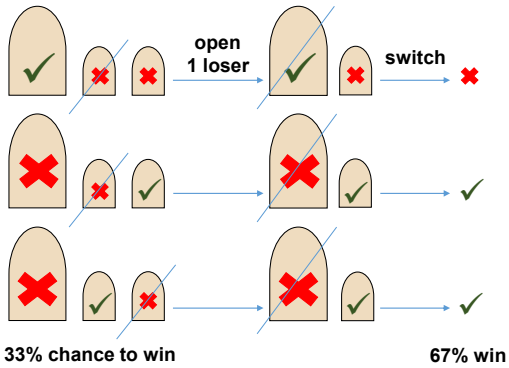
The Mexican economy continues to withstand the uncertainty linked to the US trade agenda and the reverberating effects of soaring inflation remarkably well. The peso received a lift from fading expectations of a trade war as the US and Mexico agreed to limit Mexican sugar imports into the US. The sugar deal was seen as a positive step ahead of the renegotiation of the North American Free Trade Agreement (NAFTA) this summer. Inflation rose to 6.2% in May from 5.8% in April, marking the highest level since May 2009. Inflation continued to move further above the 4.0% upper bound of the Central Bank's target range, where it is expected to remain there for most of the year.

Focus On: *Monty Hall's Alpha*

"Who wants to make a deal?!" Monty Hall's signature line added excitement to a classic gameshow which originally aired in 1963. And while the show is familiar to millions of Americans, the famous host has a more interesting legacy in the statistical brain teaser that bears his name: The Monty Hall Problem. This simple puzzler has been argued and debated by world-renown mathematicians (Paul Erdős) and pop culture "brainiacs" (Marilyn vos Savant), and posed and proven in American Statistician (Selvin 1975a and 1975b) with a version covered in Scientific American (Gardner 1959a). It even has an extensive Wikipedia entry with links to over 60 articles and books related to the problem, which goes like this:

> You are a contestant on a gameshow where you are asked to choose among three doors. Go ahead; pick one (A,B,C). Behind one of the doors is a prize of great value – a new car. Behind each of the other two doors is a prize worth nothing; in the classic example, it is a billy-goat. After you have picked your door, the host reveals what was behind one of the doors you did not choose, and it is a goat. Knowing now that the car is behind one of two remaining doors, the host offers to let you choose again. Do you stick with your original choice or switch to the other door?

Would you stick with your door or switch? The solution is to always switch, because doing so doubles your chance of winning! This is counter-intuitive to many, including Erdős himself. Simply explained, in the first round you had a 1/3 chance of choosing the door with the car and a 2/3 chance that the car was behind one of the other two doors. Since the host always takes away a losing door you did not select, by not switching you are still betting on the 1/3 chance that you originally selected the winning door. The remaining unselected door now claims the full 2/3 chance of hiding the car. The result has been proven mathematically and through computer simulation.



So, who would not switch? Interestingly, many – actually most, according to vos Savant. When she posed the problem in her nationally syndicated column, Ask Marilyn, she received thousands of letters disagreeing with her, many vehemently. Even more interesting is a behavioral bias that has been revealed in studies of the problem. While the majority of people solve the problem (incorrectly) to allot an equal probability that each of the two remaining doors hides the car, only a very small percentage of these "contestants" actually choose to switch doors. In their 1995 research article

"The Monty Hall Dilemma" in the Personality and Social Psychology Bulletin, Donald Granberg and Thad Brown reported "switchers" at only 12%. If people truly believed the odds were equal, about half should choose to switch. This suggests cognitive dissonance above and beyond the inability to correctly solve the logic problem. In many ways, the multiple issues that stand in the way of correctly solving the Monty Hall Problem are analogous to sources of alpha in investible markets. And much like the Monty Hall Problem, understanding these can produce better odds of winning the prize. The results speak both to the scarcity of skill and to the impact of behavioral biases on human decision making.

CAPM and the Components of Financial Returns

The argument for active management is simple: it beats the market, on a risk-adjusted basis, through the specific skill of a portfolio manager. The Capital Asset Pricing Model, or CAPM, is a simple model to measure active management success that has stood the test of time. The equation (shown at right) is a linear regression, taking into account:

$$\boldsymbol{R = R_f + \beta\left(R_m - R_f\right) + \alpha}$$

$Where$:

$R_f = Risk\text{–}Free\ Rate\ of\ Return$

$R_m = Market\ (At\text{–}Risk)\ Rate\ of\ Return$

Risk-Free Rate: The portion of return you receive simply for the use of your money. When there is more demand or opportunity for use of this money, or less money is available, the risk-free rate increases. The yield on 3-month US Treasury bills is often used as a proxy.

Beta: The portion of return you receive for taking market risk. An index fund investor gets all of their return through the risk-free rate and beta exposure.

Alpha: The portion of your return not explained by the risk-free rate and beta. Said differently, it's the amount by which you outperform (or underperform) the market due to factors other than the amount or risk you decided to take, primarily due to the specific investment decisions your investment manager makes.

While alpha is the goal of active management, it's only useful to us if it is sustainable. Our contestants that do not switch doors still have a 1/3 chance of winning, but if they win it's only through luck. The problem with luck is that it inevitably runs out. Examining only the past returns of an investment manager can tell you how much alpha they have generated, but it does not tell you whether the manager has a sustainable alpha source, or has merely been lucky.

The trouble is, modern portfolio theory suggests that as markets become more efficient, sustainable alpha will become increasingly scarce. In addition, actively-managed strategies always cost more – so an active investor starts with a headwind, compared to indexed investors. Alpha generation depends on skill and effort rather than risk or capital, and requires some edge over other market participants. This edge can come from size, ingenuity, labor intensive research, foresight, or private information, among other things. And because there is no additional risk associated with greater alpha, investment managers that are able to generate it can charge higher fees to compensate them for creating value.

The investor's challenge is to determine how much excess return is attributable to alpha (and warrants manger compensation) and how much is attributable to beta (for which the manager deserves little compensation). All else equal, an investor should prefer the investment strategy with the highest future alpha net of fees - simple enough if future alpha can be accurately predicted. While in the end it's a risky decision, understanding possible sources of sustainable alpha is useful. Perhaps surprisingly, Monty Hall can help.

Sources of Sustainable Alpha

Fundamentally, there are three possible sources of sustainable alpha. The first is to capitalize on an information advantage. While perhaps a great driver of alpha in the past, it has become more and more difficult to sustain a meaningful edge when it comes to information. Market regulations restrict how it can be obtained, with severe penalties for insider trading. And with the increasing efficiency of markets, expanding access to data, and advancing technology, the likelihood of maintaining an information advantage becomes less and less. Alpha often becomes beta over time. Likewise, in the Monty Hall Problem, each contestant has access to the same information within the game. It would be easy to increase your chance of winning the car if only you could look behind the doors, but this is not allowed.

The second way to increase your odds of winning is to correctly solve problems the market incorrectly solves. In financial markets, this equates to accurately calculating the intrinsic value of an investment, the approach that underpins most fundamental actively-managed strategies. In the Monty Hall problem, people have perfect information, yet very few people (including people with graduate degrees in statistics) solve the problem correctly.

Finally, a third way to capture alpha is to uncover, understand and exploit market idiosyncrasies, and this practice forms the basis for quantitative strategies. In the Monty Hall Problem, it is similar to recognizing the behavioral bias that keeps contestants from switching doors even after they have (incorrectly) solved the problem and should be indifferent to the

switch. To illustrate the points, let's assign a financial value to each of the doors in the game – making the problem more like the financial markets. Clearly a player would choose the door with the highest value. The problem is that the assumptions in modern portfolio theory that are not always present in the real world: 1) that each participant will make analytically-correct decisions, and 2) that each participant will act rationally.

Suppose the value of the car is $30,000 and the value of each of the goats is $0. At the beginning of the game, the probability that the car is behind any of the doors is 1/3, so each door would be worth 1/3 of $30,000, or $10,000. After one of the goat-hiding doors is eliminated, the true or "intrinsic" value of the selected door continues to be $10,000, but the value of the remaining unselected door becomes $20,000.

If, as in the Monty Hall Problem, investors miscalculate the odds, they would believe the two remaining doors would be equally valued at $15,000 (i.e., $30,000/2). But if we allowed the value to be set by a free market, the mispricing would get worse – because we know from surveys that only 12% of players choose to switch, not 50%. The biased "market value" of your initial door would actually be greater than $15,000 – perhaps $20,000 or more – while the other door would be even more undervalued.

	"Your" Door	"Other" Door	
Intrinsic Value	$10,000	$20,000	opportunity from investor skill
Miscalculated Value	$15,000	$15,000	
Biased Value	$20,000	$10,000	opportunity from market inefficiencies

What are the sources of alpha in this scenario? First, by correctly understanding the intrinsic value of the unselected door (i.e., $20,000), a contestant can purchase it for something below that and hold it until the rest of the players (i.e., the market) recognizes its true value. They could do that simply by being a better-than-average analyst. But they could also make more money by exploiting a market inefficiency created by our behavioral bias against switching, even in the face of new information. "Fundamental" managers seek alpha through the former – superior analytic skill – while "quantitative" managers seek alpha through exploiting inefficiencies such as behavioral biases.

Is the Search for Alpha Worth It?

Over the years, many investors seem to have stopped asking "Where can I find alpha?" and started asking "Why do I need alpha anyway?" Passive investing has taken hold in the US with substantial cashflows into index strategies. Adherents may proclaim that there is no alpha to be reliably had, but we would suggest that news of its demise has been greatly exaggerated. Some segments of the market have proven to be more resilient to the passive investment shift. Against a backdrop of low fees, active management can sometimes look expensive. However, solving the (intrinsic value) problem correctly and/or exploiting market idiosyncrasies can still lead to performance net of fees that outpaces the market.

> "...no other statistical puzzle comes so close to fooling all the people all the time... The phenomenon is particularly interesting precisely because of its specificity, its reproducibility, and its immunity to higher education."
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> - *Massimo Piattelli-Palmarini, Cognitive Psychologist on The Monty Hall Problem*

Portfolio managers face a continuous stream of Monty-Hall-like problems. The investor's challenge is to judge a manager's ability to persistently solve these ever-changing puzzles correctly. Distinguishing manager skill from luck requires experience, but fortunately more robust toolsets than the simple CAPM have been developed. While originally CAPM contemplated a single beta for market risk, the concept of multiple betas was popularized by the Fama-French Three-Factor Model in 1993. Since that time, other factors have been added. And as outlined in our 3rd quarter 2016 focus piece on Factor Investing, factor analysis that looks beyond the catch-all beta of market risk can be helpful in performance attribution and risk management. Investors should be wary of non-benchmark risks masquerading as alpha.

The Monty Hall Problem illustrates that perfect information does not necessarily lead to flawless decisions, or to perfect market efficiency. For deep, well-covered markets like largecap US stocks, one must be very skeptical about alpha. In other less efficient markets, active managers can make a more compelling argument. In either case, you should know what the manager believes their sustainable alpha source to be, and do your best to prove or disprove its existence.

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