Chapter 3
Basic Building Blocks of the Cost of Equity Capital – Risk-free Rate and Equity Risk Premium

The basic building blocks for the build-up methods and the modified capital asset pricing model (MCAPM) are:

- Risk-free rate
- Equity risk premium
- Size premium
- Beta (in CAPM or MCAPM) or industry risk premium (in build-up method)
- Company-specific risk premium

We will discuss the risk-free rate (R_f) and the equity risk premium (ERP) in this chapter. We will discuss the remaining building blocks in later chapters.

The Risk-free Rate and Equity Risk Premium: Interrelated Concepts

A risk-free rate is the return available, as of the valuation date, on a security that the market generally regards as free of the risk of default.

For valuations denominated in U.S. dollars, valuation analysts have traditionally used the spot yield to maturity (as of the valuation date) on U.S. government securities as a proxy for the risk-free rate. The two most commonly used risk-free bond maturities have been the 10- and 20-year U.S. government bond yields.

The use of (i) long-term U.S. government bonds, and (ii) an ERP estimated relative to yields on long-term bonds most closely matches the investment horizon and risks that confront business managers who are making capital allocation decisions and valuation analysts who are applying valuation methods to value a "going concern" business.

The risk-free rate and the ERP are interrelated concepts. All ERP estimates are, by definition, developed *in relation* to the risk-free rate. Specifically, the ERP is the extra return investors expect as compensation for assuming the additional risk associated with an investment in a diversified portfolio of common stocks, compared to the return they would expect from an investment in risk-free securities. The risk-free rate is intended to adjust the cost of equity (at least in part) for expected future inflation.

This brings us to an important concept. When developing cost of capital estimates, the valuation analyst should match the term of the risk-free rate used in the CAPM or build-up formulas with the duration of the expected net cash flows of the business, asset, or project being evaluated.[3.1] Further, the term of the risk-free rate should *also* match the term of the risk-free rate used to develop the ERP, as illustrated in Exhibit 3.1.

Exhibit 3.1: The Risk-free Rate and ERP Should Be Consistent with the Duration of the Net Cash Flows of the Business, Asset, or Project Being Evaluated

Term of risk-free rate used in CAPM or Build-up equation	=	Expected duration of the net cash flows of the business, asset, or project being evaluated	=	Term of risk-free rate used to develop the ERP

In many of the cases in which one is valuing a business, a "going concern" assumption is made (the life of the business is assumed to be long-term or indefinite), and therefore selecting longer-term U.S. government bond yields as the proxy for the risk-free rate is appropriate. For example, valuation analysts typically use a 20-year U.S. government bond yield when developing a U.S. dollar denominated cost of equity capital.

The risk-free rate and the ERP, like all components of the cost of equity capital (and the cost of equity capital itself), are *forward-looking* concepts. The reason that the cost of capital is a forward-looking concept is straightforward: when we value a company (for instance), we are trying to value how much we would pay (now) for the *future* economic benefits associated with owning the company. Since we will ultimately use the cost of capital to discount these future economic benefits (usually measured as *expected* cash flows) back to their present value, the cost of capital itself must *also* be forward-looking.

Spot Risk-free Rates versus Normalized Risk-free Rates

Beginning with the global financial crisis of 2008 (the "Financial Crisis"), analysts have had to reexamine whether the "spot" rate is still a reliable building block upon which to base their cost of equity capital estimates. The Financial Crisis challenged long-accepted practices and highlighted potential problems of simply continuing to use the spot yield-to-maturity on a safe government security as the risk-free rate, without any further adjustments.

During periods in which risk-free rates appear to be abnormally low due to flights to quality or massive central bank monetary interventions, valuation analysts may want to consider normalizing the risk-free rate. By "normalization" we mean estimating a risk-free rate that more likely reflects the *sustainable* average return on long-term U.S. government bond without the impact of flight-to-quality or the impact of monetary intervention designed to maintain lower risk-free rates. In periods

[3.1] Certain sections of this chapter are based in part on Shannon P. Pratt and Roger J. Grabowski, *Cost of Capital: Applications and Examples* 5th ed. (Hoboken, NJ: John Wiley & Sons, 2014).

of increased economic uncertainties, investors favor the purchase of safe assets (i.e., sovereign bonds) against risky assets. These periods are termed flight-to-quality. During flight-to-quality, one witnesses large scale sale of risky assets and purchase of risk-free assets not for return but rather for capital preservation.

Why Normalize the Risk-free Rate?

Material distortions to *spot* government debt yields can occur during periods characterized by significant flight-to-quality investment flows or by central bank monetary policies that entail significant intervention in sovereign debt securities markets and/or the implementation of negative interest rate policies, since these may (i) distort long-term yields by reducing term premiums that no longer reflect market expectations of long-term inflation; and even (ii) drive short-term *real* yields to negative levels (i.e., below 0.0%), which will no longer reflect the time value of money and implicitly assumes that the real rate of growth for the overall economy will be negative.

We introduced the concept of normalized risk-free rate to measure the risk-free that would prevail under normal market and monetary conditions. The current monetary conditions are unusual. Most developed countries' central banks are holding massive amounts of sovereign bonds and other instruments in their respective balance sheets. This exerts pressure on sovereign bond prices. To be clear, the normalized risk-free rate is not a long-term average of risk-free rates. It is estimated based on current expected real rate of interest rates plus current expected inflation.

Since the risk-free rate and the ERP are interrelated concepts, and because the (nominal) risk-free rate is intended to adjust the cost of equity (at least in part) for expected future inflation, simply using a spot rate that suffers from the problems highlighted above may also distort the cost of equity. One must understand the magnitude of the impact on the risk-free rate due to flight-to-quality and central bank monetary policies if one is to understand the appropriate ERP to match with the risk-free rate when valuing an equity investment or "going concern" business.

Review of Monetary Policy

The yields of U.S. government bonds in certain periods during and after the Financial Crisis may have been *artificially* repressed, and therefore likely unsustainable. Many market participants would agree that nominal U.S. government bond yields have been artificially low for almost a decade. Even members of the Federal Open Market Committee ("FOMC") have openly discussed the need to "normalize" interest rates, as documented in the minutes of meetings held over the last several years, as well as in a statement released in September 2014, entitled "Policy Normalization Principles and Plans", which was subsequently augmented at its March 2015 and June 2017 meetings.[3.2, 3.3]

The Federal Reserve ("Fed") kept a zero-interest-rate policy (dubbed "ZIRP" in the financial press) for seven years. After a nearly 10-year period with only one interest rate hike, the Fed embarked on a path of monetary policy normalization.[3.4] On December 17, 2015, the Fed raised the federal funds (Fed funds) by 25 basis points (b.p.) to 0.25%–0.50%.[3.5] More 25 b.p. rate hikes followed in *each* of the subsequent meetings in: December 2016, March 2017, June 2017, December 2017, March 2018, June 2018, September 2018, and December 2018.[3.6] The Fed followed a consistent normalization policy despite a February 2018 change in its leadership.[3.7] Over the course of approximately 3 years, the FOMC has raised rates a total of nine times in 25 b.p. increments, resulting in a Fed funds range of 2.25%—2.50% as of December 31, 2018, still very low by historical standards.[3.8]

3.2 The "Policy Normalization Principles and Plans", dated September 16, 2014, is available at: https://www.federalreserve.gov/monetarypolicy/files/FOMC_PolicyNormalization.pdf. The "Addendum to the Policy Normalization Principles and Plans", dated June 13, 2017 is available at: https://www.federalreserve.gov/monetarypolicy/files/FOMC_PolicyNormalization.20170613.pdf. For the latest updates on the on FOMC communications related to policy normalization, visit the "Policy Normalization" site located here: https://www.federalreserve.gov/monetarypolicy/policy-normalization.htm. To access minutes of FOMC meetings visit: https://www.federalreserve.gov/monetarypolicy/fomccalendars.htm.

3.3 The Federal Reserve System is the central bank of the United States. It performs five general functions to promote the effective operation of the U.S. economy and, more generally, the public interest. The Federal Reserve: (i) conducts the nation's monetary policy, (ii) promotes the stability of the financial system, (iii) promotes the safety and soundness of individual financial institutions, (iv) fosters payment and settlement system safety and efficiency, (v) promotes consumer protection and community development. The Federal Reserve System includes three key entities: the Board of Governors, 12 Federal Reserve Banks, and the Federal Open Market Committee (FOMC). The FOMC sets U.S. monetary policy in accordance with its mandate from Congress: to promote maximum employment, stable prices, and moderate long-term interest rates in the U.S. economy. To learn more about the Federal Reserve System, visit https://www.federalreserve.gov/aboutthefed.htm.

3.4 Prior to the December 17, 2015 target federal funds rate hike, the most recent rate hike imposed by the Fed was a 25 b.p. rate hike on June 29, 2006 (approximately 9.5 years prior to December 2015).

3.5 The federal funds rate is the interest rate at which depository institutions lend balances to each other overnight, the Fed funds rate is used as the benchmark interest rate to implement U.S. monetary policies, such as raising or reducing interest rates. The Federal Open Market Committee (FOMC) establishes the target rate (or range), for trading in the federal funds market. For more details, visit https://apps.newyorkfed.org/markets/autorates/fed%20funds.

3.6 The initial series of five rate hikes (Dec. 2015-Dec. 2017) was enacted under Fed Chair Janet Yellen. Yellen served as Fed Chair from Feb. 3, 2014 through Feb. 3, 2018.

3.7 On February 5, 2018, Jerome H. Powell took the oath of office as the Fed's Chairman, succeeding Janet L. Yellen. President Trump announced his intention to nominate Mr. Powell as the Fed's Chairman in November 2017. For more details, visit: https://www.federalreserve.gov/newsevents/pressreleases/other20180205a.htm.

3.8 Based on available historical data, the federal funds rate has not been at these low levels for a prolonged period of time since the mid -1950s to early 1960s, a period that included three economic recessions in the United States. A shorter two-year period of federal funds rates this low was observed during 2002–2004, following a brief U.S. economic recession, the September 11, 2001 terrorist attacks on U.S. soil, and the burst of the internet (a.k.a., dot-com) bubble of the 1990s. For a timeline of U.S. economic recessions refer to "U.S. Business Cycle Expansions and Contractions", National Bureau of Economic Research at: http://www.nber.org/cycles.html. For historical effective federal funds rates, visit: https://www.federalreserve.gov/releases/h15/data.htm.

The Fed stated objective in normalizing monetary policy was to set the Fed funds rate at a neutral level (i.e., neither expansionary nor restrictive), while still promoting its statutory mandate of maximum employment and price stability. This theoretical level of interest rates is not directly observed in the economy. If the FOMC increases rates beyond the neutral rate, it raises the probability that the economy enters a recession. Similarly, if the rate is kept lower than the neutral rate, it fuels inflation that might not be contained easily. The FOMC must walk a fine line between increasing the policy rate without chocking the economic growth or causing excessive inflation in the economy.

The Fed's task is complicated by the fact that monetary policy work with a lag. The effect of the FOMC decisions are not seen on the economy immediately.[3.9] It is important to differentiate between financial markets and the underlying economy. Financial markets can discount future perceived events into prices relatively quickly, while the effects of monetary policy can take some time to work their way through the economy.

During the June 12–13, 2018 FOMC meeting, the committee raised interest rates by 25 b.p. and expressed satisfaction with the current economic conditions especially the strong labor market and inflation close to target. The committee was careful to link future adjustments of the Fed funds to future economic conditions while indicating that the median Fed funds rates was expected to be at 2.4% by the end of 2018.[3.10] Most importantly, the post-meeting press release indicated that the committee considered the stance of monetary policy, at that point, to still be "accommodative".

In the FOMC meeting held on September 25–26, 2018, the committee turned silent on how it perceived its own monetary policy. For the first time since late 2015, the FOMC statement did not describe its monetary policy as "accommodative".[3.11] The removal of this description suggests that the FOMC did not consider the current level of interest rates as expansionary. At the same time, the FOMC members' forecasts indicated that they were planning another rate hike at their December meeting.

According to the September 25–26 meeting's minutes, the committee was still worried about the possibility that keeping interest rates lower might lead to higher inflation: [3.12]

> *"This gradual approach would balance the risk of tightening monetary policy too quickly, which could lead to an abrupt slowing in the economy and inflation moving below the Committee's objective, against the risk of moving too slowly, which could engender inflation persistently above the objective and possibly contribute to a buildup of financial imbalances,"*

3.9 Friedman, Milton. "The lag in effect of monetary policy." Journal of Political Economy 69, no. 5 (1961): 447-466. A copy can be accessed here: https://www.journals.uchicago.edu/doi/abs/10.1086/258537?journalCode=jpe.

3.10 "FOMC press release" June 13, 2018. A copy of the press release can be accessed here: https://www.federalreserve.gov/newsevents/pressreleases/monetary20180613a.htm.

3.11 "FOMC press release" September 26, 2018. A copy of the press release can be accessed here: https://www.federalreserve.gov/newsevents/pressreleases/monetary20180926a.htm.

3.12 To access minutes of FOMC meetings visit: https://www.federalreserve.gov/monetarypolicy/fomccalendars.htm.

Richard Clarida, the newly appointed Vice Chairman of the Fed and a member of the FOMC, stated in an October 25, 2018 address that "…the economy is as near as it has been in a decade to meeting both of the Fed's dual-mandate objectives… [and] the risks that monetary policy must balance are now more symmetric and less skewed to the downside" [3.13] [emphasis added]. In keeping with that, Clarida said that some further gradual adjustment in the Fed funds rate would "be appropriate", but did acknowledge that "raising rates too quickly could unnecessarily shorten the economic expansion"…and that "at this stage in the business cycle it is especially important" to monitor a wide range of data to assess monetary policy consistent with the Fed's mandate.

The same thinking was echoed by the Chairman of the Fed, Jerome Powell, and other Fed presidents. In a speech on November 28, 2018, Mr. Powell described the level of interest rates, when the Fed funds range was 2.00%-2.25%, as follows: [3.14]

> *"Interest rates are still low by historical standards, and they remain just below the broad range of estimates of the level that would be neutral for the economy – that is, neither speeding up nor slowing down growth. My FOMC colleagues and I, as well as many private-sector economists, are forecasting continued solid growth, low unemployment, and inflation near 2 percent."*

The key words in this statement are: "just below". Similarly, Raphael Bostic, the president of the Federal Reserve bank of Atlanta, expressed his belief that the FOMC have "likely" reached a neutral level with the Fed funds range at 2.25%–2.50%.[3.15] Since the December 18–19, 2018 meeting, the FOMC adopted a "wait and see" strategy.

While the views of regional Fed Presidents or individual FOMC members do not necessarily reflect the official positions of the committee, it may be reasonable to assume that short-term interest rates are expected to stay at this level. Yet, what is considered "normal" today may ultimately be lower than imagined prior to the Financial Crisis. We will elaborate on the consequences of this statement later in this chapter.

So, what does it mean when someone says the current U.S. Government bonds are not "normal"? And even if interest rates are not considered "normal", why is that any different from other periods in history? Remember, the risk-free rate is intended to adjust the cost of equity capital (at least in part) for expected future inflation. Therefore, the risk-free rate should reflect the expected real rate plus expected inflation.

[3.13] Clarida made these remarks during a presentation at the Peterson Institute for International Economics in his first public appearance since he was appointed in October 25, 2018. A copy of Clarida's remarks can be accessed here: https://www.federalreserve.gov/newsevents/speech/clarida20181025a.htm.

[3.14] Powell, Jerome H., "The Federal Reserve's Framework for Monitoring Financial Stability," speech delivered on November 28, 2018 at the New York Economic Club, New York, N.Y. A copy of the speech can be accessed here: https://www.federalreserve.gov/newsevents/speech/powell20181128a.htm.

[3.15] Bostic, Raphael "Defining Data Dependence," speech delivered on January 9, 2019 at the Chattanooga Area Chamber of Commerce, Economic Outlook Breakfast, Chattanooga, Tennessee. A copy of the speech can be accessed here: https://www.frbatlanta.org/news/speeches/2019/01/09-bostic-defining-data-dependence.

Why isn't the Current Long-Term Spot Risk-Free Rate Considered "Normal"?

The traditional monetary policy tool used by the Fed has been the target Fed funds rate. FOMC changes to the target Fed funds rate can only affect the short-term end of the yield curve, whereas the long-term interest rates are set by the demand and supply for the long-term maturities depending on the market perceived long-term economic growth. Nevertheless, the dominant theory of the term structure (the expectation hypothesis) explains that long-term interest rates are averages of the short-term ones plus a term premium.[3.16] Hence, an increase or decrease in the short-term rates should eventually move the whole yield curve up or down and lead to a change in the long-term rates, everything else held the same.

The Fed intentionally intervened in the bond market after the Financial Crisis to stimulate the economy and help in its recovery. For example, at the September 13, 2012 FOMC press conference, the Fed Chairman at the time, Ben Bernanke, stated:[3.17]

> *"...the tools we have involve affecting financial asset prices...To the extent that home prices begin to rise, consumers will feel wealthier, they'll feel more disposed to spend ... So house prices is one vehicle. Stock prices – many people own stocks directly or indirectly...and if people feel that their financial situation is better because their 401(k) looks better or for whatever reason, their house is worth more, they are more willing to go out and spend, and that's going to provide the demand that firms need in order to be willing to hire and to invest."*

When the Fed started its most recent monetary tightening cycle by affecting rates on the *short* end of the yield curve, the likely expectation was that this would manifest similar increases on the *long* side of the yield curve. However, from November 2015 through December 2018 the target Fed funds range was increased by a total of 225 b.p., and the longer 10-year Treasury yield increased by only 48 b.p.[3.18]

3.16 The term premium is defined as the compensation investors require for holding a long-term bond compared to rolling over a series of short-term bonds with lower maturity.

3.17 FOMC: Press Conference on September 13, 2012. To obtain the press conference transcript, visit: https://www.federalreserve.gov/monetarypolicy/fomcpresconf20120913.htm.

3.18 10-year yield was 2.21% and 2.69% on November 30, 2015 and December 31, 2018, respectively. Source: S&P Capital IQ.

The responsiveness (or lack thereof) of longer-term interest rates to monetary policies that target the shorter end of the yield curve has been a puzzle for some time. For example, between June 2004 and June 2006 the FOMC *increased* the Fed funds 17 times (from 1.00% to 5.25%), but long-term interest rates *declined* or stayed flat until early 2006. Former Fed Chairman Allan Greenspan testified before the U.S. Senate Committee on Banking, Housing, and Urban Affairs on February 16, 2005, and he stated:[3.19]

> *"In this environment, long-term interest rates have trended lower in recent months even as the Federal Reserve has raised the level of the target federal funds rate by 150 basis points. This development contrasts with most experience, which suggests that, other things being equal, increasing short-term interest rates are normally accompanied by a rise in longer-term yields. The simple mathematics of the yield curve governs the relationship between short- and long-term interest rates. Ten-year yields, for example, can be thought of as an average of ten consecutive one-year forward rates. A rise in the first-year forward rate, which correlates closely with the federal funds rate, would increase the yield on ten-year U.S. Treasury notes even if the more-distant forward rates remain unchanged."*

Greenspan described this "unanticipated behavior" as a "conundrum". Shortly after his testimony the yield curve inverted in July 2006 and a recession started in December 2007. Traditionally, market participants consider a yield curve inversion a recession indicator.[3.20, 3.21]

In 2018, the speed of the Fed's rate hikes and the stability of long-term rates flattened the yield curve. The spread between the 10-year and the 3-month yields decreased from 101 b.p. on December 29, 2017 to 24 b.p. on December 31, 2018.[3.22] As this difference became smaller, the probability of a yield curve inversion increased. Between March 22, 2019 and March 28, 2019, the difference between the 10-year the 3-month yields turned negative, but some economists explained that the conditions for a recession are not met even if the yield curve became inverted. When asked to comment about this short lived inversion, Fed Board of Governors member Randal Quarles attributed the current shape of the yield curve to "the central bank's balance sheet shrinkage", adding "I don't view it as much of a harbinger" (of recession, presumably). Other market participants shared a similar thinking.

3.19 Remarks made at: Federal Reserve Board's semiannual Monetary Policy Report to the Congress before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate (Greenspan presented identical testimony before the Committee on Financial Services, U.S. House of Representatives, on February 17, 2005). A copy of Greenspan's remarks can be accessed here: https://www.federalreserve.gov/boarddocs/hh/2005/february/testimony.htm.

3.20 National Bureau of Economic Research determines the start and end dates of recessions in the U.S. A complete list of recession since 1845 can be found here: https://www.nber.org/cycles.html.

3.21 The yield curve predicted the last three recessions since 1982. The spread between 10-year and 3-month yields turned negative between May 22, 1989 and July 3, 1989; a recession stared July 1990. The spread between 10-year and 3-month yields turned negative between July 7, 2000 and January 19, 2001; a recession followed in March 2001. The spread between 10-year and 3-month yields turned negative between July 17, 2006 and May 29, 2007; a recession followed in December 2007. Source of data St. louis Federal reserve Bank's FRED: https://fred.stlouisfed.org/series/T10Y3M.

3.22 Source of data St. Louis Federal reserve Bank's FRED: https://fred.stlouisfed.org/series/T10Y3M.

Mohamed El-Erian, chief economic adviser at Allianz and a well-known economic commentator stated: "The yield curve's signal is not what it used to be." [3.23]

A recently published paper posits that the relationship between the Fed funds rate and longer-term rates (specifically, 10-year Treasuries) was "severed" in the late 1980s when the Fed began using the Fed funds rate as a policy instrument.[3.24] The author argues that this change "…caused the funds rate to be determined by monetary policy consideration and not by economic fundamentals as before", whereas the longer 10-year yield "continued to be determined by economic fundamentals", causing the relationship between the two to "vanish". If the author is correct, this might suggest that an inversion of the yield curve may be less predictive of an ensuing economic downturn.

The Fed's Balance Sheet

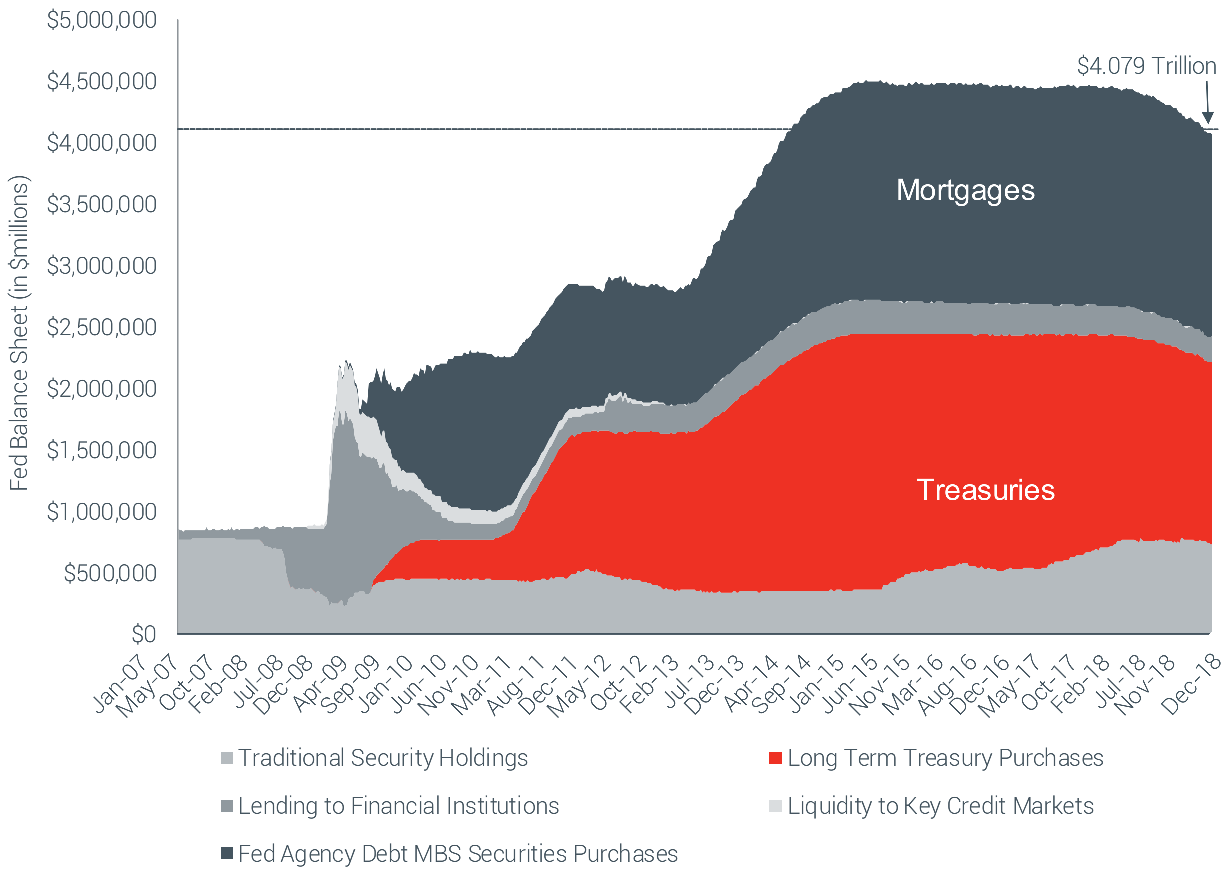
One of the reasons that the yield curve signaling power may not be "what it used to be" is the intervention of the central banks in their countries respective sovereign bond markets. In Exhibit 3.2, the balance sheet of the Fed is shown over time. Since the Financial Crisis, the Fed purchased massive quantities of U.S. government bonds, agency debt, and mortgage backed securities (MBS) through a series of so-called quantitative easing (QE) measures. At the end of December 2017, the Fed's balance sheet reached $4.5 trillion, down slightly, but essentially unchanged from December 2016. At the end of December 2018, the Fed's balance sheet had declined to $4.08 trillion, representing a decline of nearly 9.6% from its all-time high. [3.25]

[3.23] Robin Wigglesworth and Joe Rennison "Has the yield curve predicted the next US downturn?" ft.com, April 4, 2019.

[3.24] Thornton, Daniel L. "Greenspan's Conundrum and the Fed's Ability to Affect Long-Term Yields." *Journal of Money, Credit and Banking* 50, no. 2-3 (2018): 513-543.

[3.25] The Fed's balance sheet reached an all-time high of $4.513 trillion on February 18, 2015.

Exhibit 3.2: Balance Sheet of the Federal Reserve (vis-à-vis Credit Easing Policy Tools)
January 2007–December 2018



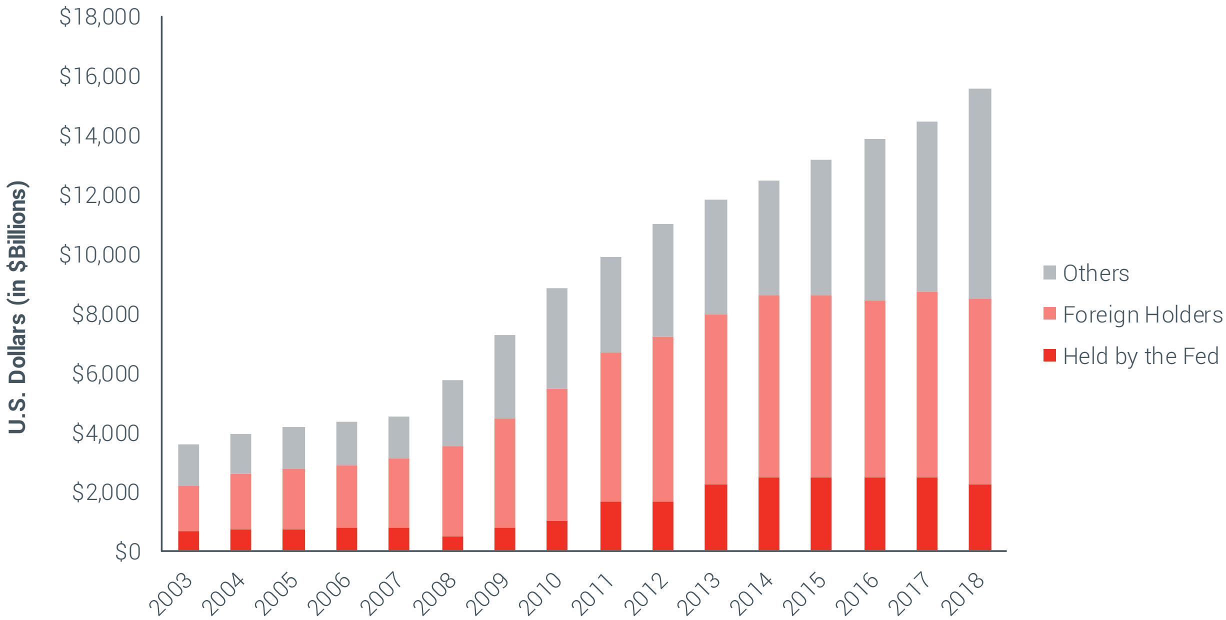
Source of underlying data: Federal Reserve Bank of Cleveland. To learn more, visit: https://www.clevelandfed.org.

In the post-Financial crisis period, some analysts estimated that the Fed's purchases accounted for a growing majority of new U.S. government bond issuances. In early 2013 in the online version of the *Financial Times*, one analyst wrote, *"The Fed, the biggest buyer in the market, has been the driver of artificially low Treasury yields"*.[3.26]

[3.26] Michael Mackenzie, "Fed injects new sell-off risk into Treasuries", ft.com, January 8, 2013.

In Exhibit 3.3, we show the aggregate dollar amount of marketable securities issued by the U.S. Department of Treasury (e.g., bills, notes, bonds, inflation-indexed securities, etc.) from 2003 through December 2018. We also display how much of the U.S. public debt is being held by the Fed, foreign investors (including official foreign institutions), and other investors.

Exhibit 3.3: Marketable U.S. Government Securities Held by the Public December 2003–December 2018



Source of underlying data: Federal Reserve Bank of St. Louis Economic Research; U.S. Department of the Treasury. Compiled by Duff & Phelps, LLC.[3.27]

Notably, the issuance of marketable interest-bearing debt by the U.S. government to the public increased more than threefold between the end of 2007 and 2018. Keeping everything else constant, the law of supply and demand would tell us that the dramatic *increase* in supply would lead to a significant *decrease* in government bond prices, which would translate into a surge in yields. But that is not what happened (e.g., the yield on 20-year U.S. government bonds fell from 4.50% at the end of 2007 to 2.87% at the end of 2018).[3.28] During the same period, the Fed more than tripled its holdings of U.S. government bonds, representing a 10.4% compound annual growth rate through the end of 2018.[3.29]

3.27 Sources included: (i) Board of Governors of the Federal Reserve System (US), U.S. Treasury securities held by the Federal Reserve: All Maturities [TREAST], retrieved from FRED, Federal Reserve Bank of St. Louis, https://research.stlouisfed.org/fred2/series/TREAST/, February 23, 2019; (ii) Monthly Statements of the Public Debt (MSPD) retrieved from https://www.treasurydirect.gov/govt/reports/pd/mspd/mspd.htm, February 23, 2019; and (iii) U.S. Department of the Treasury International Capital (TIC) System's Portfolio Holdings of U.S. and Foreign Securities – A. Major Foreign Holders of U.S. Treasury Securities retrieved from http://www.treasury.gov/resource-center/data-chart-center/tic/Pages/ticsec2.aspx, February 23, 2019.

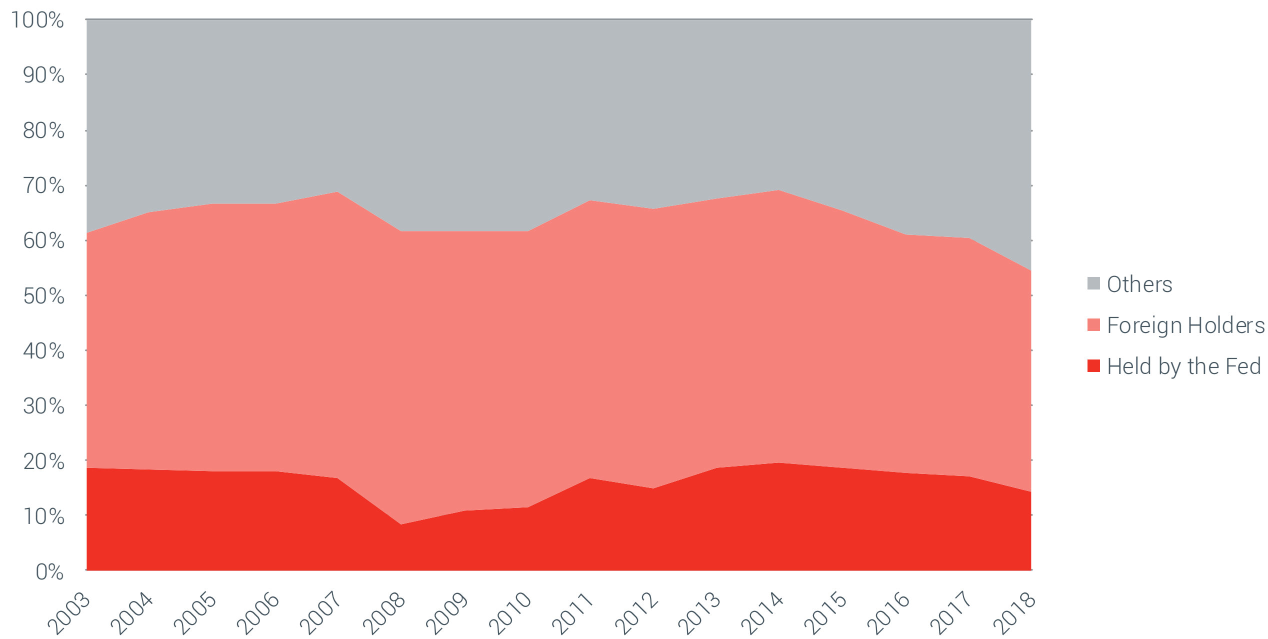
3.28 Source of underlying data: Constant maturity 20-year U.S. Government bond series, Board of Governors of the Federal Reserve System website at: http://www.federalreserve.gov/releases/h15/data.htm. Calculations by Duff & Phelps, LLC.

3.29 In Exhibit 3.3, U.S. marketable debt held by the Fed was $755 billion at the end of 2007, and $2,241 billion at the end of 2018.

Between 2003 and 2008, the Fed's holdings of U.S. government securities had held fairly constant in the vicinity of $700 to $800 billion, with December 2008 being the significant exception, when holdings dropped to approximately $476 billion. The first QE program was announced by the FOMC in November 2008, and formally launched in mid-December 2008. After that period, the various QE programs implemented by the Fed have absorbed a sizable portion of the increase in U.S. government securities issuance. The Fed's holding of marketable U.S. government securities (in dollar amount) reached a peak during the 2014–2016 period (at approximately $2.46 billion) and started decreasing in 2017 and 2018. Since the Fed started its normalization process, these holdings have decreased by approximately 9% from their 2014–2016 peak.[3.30]

Likewise, broad demand for safe government debt by foreign investors, amid the global turmoil that followed the Financial Crisis, has absorbed another considerable fraction of new U.S. government securities issuances. How significant are these purchases by the Fed and foreign investors? Exhibit 3.4 shows the same information as in Exhibit 3.3, but displays the relative share of each major holder of marketable U.S. government securities from 2003 to 2018.

Exhibit 3.4: Relative Holdings of Marketable U.S. Government Securities Held by the Public December 2003–December 2018



Source of underlying data: Federal Reserve Bank of St. Louis Economic Research; U.S. Department of the Treasury. Compiled by Duff & Phelps, LLC.

At the end of 2018, the relative share of U.S. government securities held by the Fed and foreign investors was approximately 14% and 40% respectively, for a combined 55% (difference due to rounding). This was down from 60% in 2017, and significantly lower than the 65% average of the preceding 15 years (2003–2017).[3.31]

[3.30] At year-end 2014, 2015, and 2016, the Fed's holdings of U.S. government securities were $2,461 billion, $2,462 billion, and $2,464 billion, respectively. At the end of 2018, the Fed's holdings of U.S. government securities were $2,241 billion.

[3.31] Over the 2003–2017 period, the relative share of U.S. government securities held by the Fed and foreign investors reached a peak of 69% in 2014.

However, as indicated above, the dollar amount of U.S. government securities outstanding has tripled after 2007, which means that the Fed and foreign investors have been absorbing a significant fraction of the increased issuance of U.S. government securities. The relative share of U.S. government securities held by foreign investors have been declining since its peak of 51% in 2012. This percentage is at 40% at the end of December 2018, the lowest level seen in at least 15 years.

At the same time, Japan overtook China as the country with the largest holdings of U.S. government securities in 2016, as China reduced its investments to their lowest level since 2010. That downward trend continued through early 2017. However, by December 2018 China had regained the top spot as the largest holder of U.S. government securities, a trend that should be monitored in the future. Given the current trade tensions between China and the United States (to be discussed later in this chapter), there is a possibility that China decides to change its investment policy and limit its purchases of U.S. government securities. Should China decide to dispose of a significant portion of its portfolio of U.S. government securities, there could be upward pressure in U.S. interest rates.

Interestingly, a look at the composition of foreign investors reveals that from 2006 through 2015 over two-thirds are actually foreign official institutions (i.e., central banks and central governments of foreign countries); this declined to approximately 64% in 2016 and held steady in 2017 and 2018. Thus, in aggregate, 42% of the outstanding marketable U.S. government securities are still currently held by either foreign governments or central banks around the world (including the Fed).[3.32, 3.33]

Impact of QE on Long-term Interest Rates

A team of researchers studied the impact that this massive amount of U.S. government purchases by foreign investors and the Fed have had on long-term real rates. Specifically, using data through November 2012, the authors estimated that by 2008 foreign purchases of U.S. government had cumulatively reduced 10-year real yields by around 80 b.p. The subsequent Fed purchases through the various QE programs implemented in the 2008–2012 period was estimated to incrementally depress 10-year real yields by around 140 b.p. Combining the impact of Fed and foreign investor purchases of U.S. government, real 10-year yields were depressed by 2.2% at the end of 2012, according to these authors' estimates.[3.34]

In a recent academic study (June 2017), the authors shared empirical evidence suggesting that the composition of the Fed's balance sheet can significantly affect prices of U.S. government securities (and therefore their yields), as well as the term structure of interest rates. We agree with this, given the strong evidence in recent years that the Fed has executed actions that have had a *significant*

3.32 Source: Treasury International Capital (TIC) System's Portfolio Holdings of U.S. and Foreign Securities – A. Major Foreign Holders of U.S. Treasury Securities retrieved from http://www.treasury.gov/resource-center/data-chart-center/tic/Pages/ticsec2.aspx, February 23, 2019. For a description of foreign official institutions, visit "TIC Country Codes and Partial List of Foreign Official Institutions" at: http://www.treasury.gov/resource-center/data-chart-center/tic/Pages/foihome.aspx.

3.33 At the end of 2018, foreign central banks and governments held 63% of the total share of U.S. government securities held by foreign investors, which (as previously stated) is 40% of overall all holdings. Thus, foreign central banks own approximately 25% (40% x 63%) of overall holdings. The Fed's share total share of U.S. government securities is 17%. Combining the share of U.S. government bonds held by the Fed (17%) with the proportion held by foreign central banks and governments (25%) would result in an aggregate amount of 42%.

3.34 Kaminska, Iryna, and Gabriele Zinna. "Official Demand for US Debt: Implications for US real interest rates". No. 14-66. International Monetary Fund, 2014.

effect on interest rates. This is a fairly recent change in thinking in the academic and financial community – a seeming paradigm in previous theoretical literature was that the ability of the Fed to have an impact on long-term interest rates is limited. In a separate academic study, released in April 2017, the authors estimated that the cumulative effect of the Fed's QE programs resulted in a reduction in the 10-year U.S. government securities yield term premium of about 100 b.p. at year-end 2016. In an updated analysis, these same academics estimated the impact would have decreased to 85 b.p. by the end of 2017. For practical purposes, this is what this estimate would translate into: in absence of QE actions by the Fed, the 10-year yield of 2.69% as of December 31, 2018 would likely have been around 3.54% (2.69% + 0.85%) instead.[3.35, 3.36, 3.37, 3.38]

The impact of QE is expected to diminish over time, as the Fed unwinds its portfolio of U.S. government securities, MBS, and agency debt. In its June 2017 meeting, the Fed revealed some details on its strategy to reduce its $4.5 trillion balance sheet, corroborated at its July meeting – this slow and lengthy unwinding process began in October 2017. The Fed has cited improvements in economic activity, labor market conditions, and a gradual increase in inflation measures towards its target, as support for rate increases and QE unwinding (or "QExit", as labeled in some of the financial press).

Exhibit 3.5 shows the schedule of securities held by the Fed that are allowed to expire (i.e., mature) each month under the new plan. In other words, the maximum monthly amount allowed to be removed from the Fed's balance sheet. Under this new plan, the Fed established two separate monthly caps: one for expiring U.S. government securities, and another for expiring MBS and agency debt. To the extent that the principal (in dollar amount) of the maturing securities (U.S. government securities + MBS + agency debt) is greater than the monthly cap, the excess is reinvested by the Fed. In contrast, if the principal of the maturing securities is less than the monthly cap, the Fed's balance sheet goes down by the (lower) expired principal amounts.

3.35 Huther, Jeffrey, Jane Ihrig, and Elizabeth Klee (2017). "The Federal Reserve's Portfolio and its Effect on Interest Rates," Finance and Economics Discussion Series 2017-075. Washington: Board of Governors of the Federal Reserve System, accessible here: https://doi.org/10.17016/FEDS.2017.075.

3.36 Bonis, Brian, Jane Ihrig, and Min Wei (2017). "The Effect of the Federal Reserve's Securities Holdings on Longer-term Interest Rates," FEDS Notes. Washington: Board of Governors of the Federal Reserve System, April 20, 2017, https://doi.org/10.17016/2380-7172.1977.

3.37 Bonis, Brian, Jane Ihrig, and Min Wei (2017). "Projected Evolution of the SOMA Portfolio and the 10-year Treasury Term Premium Effect," FEDS Notes. Washington: Board of Governors of the Federal Reserve System, September 22, 2017, available here: https://doi.org/10.17016/2380-7172.2081.

3.38 In a paper published in June 2018, the authors argue that the impact of the Fed buying program might be smaller than was initially thought. The authors of the study have argued that the Fed's actions and announcements are not dominant determinants of the 10-year yield and that any effect that Fed actions might have on long-term yields does not persist. Greenlaw, David, James D. Hamilton, Ethan Harris, and Kenneth D. West. "A Skeptical View of the Impact of the Fed's Balance Sheet" (June 2018). NBER Working Paper No. w24687. Available at SSRN: https://ssrn.com/abstract=3194838.

Exhibit 3.5: Monthly Caps and Actual Quarterly Reduction in Federal Reserve's Security Holdings[3.39]

	Monthly Cap: Maturing U.S. Treasury Securities	Monthly Cap: Maturing MBS & Agency Debt	Monthly Cap: Total Maturing Treasuries, MBS, & Agency Debt	(A) End-of-Quarter Cumulative Cap (3 mos. x monthly cap)	(B) Actual Quarterly Change Holdings	Shortfall (A - B)
Oct - Dec 2017	$6 billion	$4 billion	$10 billion	$30 billion	$17 billion	$13 billion
Jan - Mar 2018	$12 billion	$8 billion	$20 billion	$60 billion	$40 billion	$20 billion
Apr - Jun 2018	$18 billion	$12 billion	$30 billion	$90 billion	$82 billion	$8 billion
Jul - Sep 2018	$24 billion	$16 billion	$40 billion	$120 billion	$105 billion	$15 billion
Oct - Dec 2018*	$30 billion	$20 billion	$50 billion	$150 billion	$117 billion	$33 billion

Source of underlying data: Federal Reserve Bank of St. Louis Economic Research; Federal Reserve Bank of New York. Compiled by Duff & Phelps, LLC.

*Based on information available as of December 2018, the monthly cap for October 2018 remained in effect for subsequent months until the Fed made a decision on the future size of its balance sheet. In March 2019, the Fed made a policy announcement that laid out a new schedule starting in May 2019.

For example, during the calendar quarter of October through December 2018 (see the last row of Exhibit 3.5), the monthly cap of maturing U.S. government securities was $30 billion, and the combined cap of MBS and agency debt was $20 billion, for an aggregate amount of $50 billion per month, or a $150 billion cap (3 months x $50 billion) for the whole quarter. However, the actual amount of U.S. government securities, MBS, and agency debt that matured during the quarter was only $117 billion, and so the Fed's balance of these securities declined $117 billion ($33 billion short of the maximum $150 billion cap for the quarter).

At the end of 2018, the size of the Fed's balance sheet had declined to $4.1 trillion. Based on the plan outlined in Exhibit 3.5 and the pattern of balance sheet reductions seen thus far, it would not be unreasonable to conclude the impact of QT would create only gradual (and arguably muted) upward pressure on interest rates.

[3.39] See: "Balance Sheet Normalization Principles and Plans", May 20, 2018. Under the new plan, the current monthly cap of $30 billion for U.S. Treasury security holdings will be reduced to $15 billion beginning in May 2019 through the end of September 2019, at which point the reduction process will cease. A different schedule applies to holdings of agency debt and MBS. Additional information is available here: https://www.federalreserve.gov/newsevents/pressreleases/monetary20190320c.htm.

James Bullard, President of the Federal Reserve Bank of St. Louis, recently stated:[3.40]

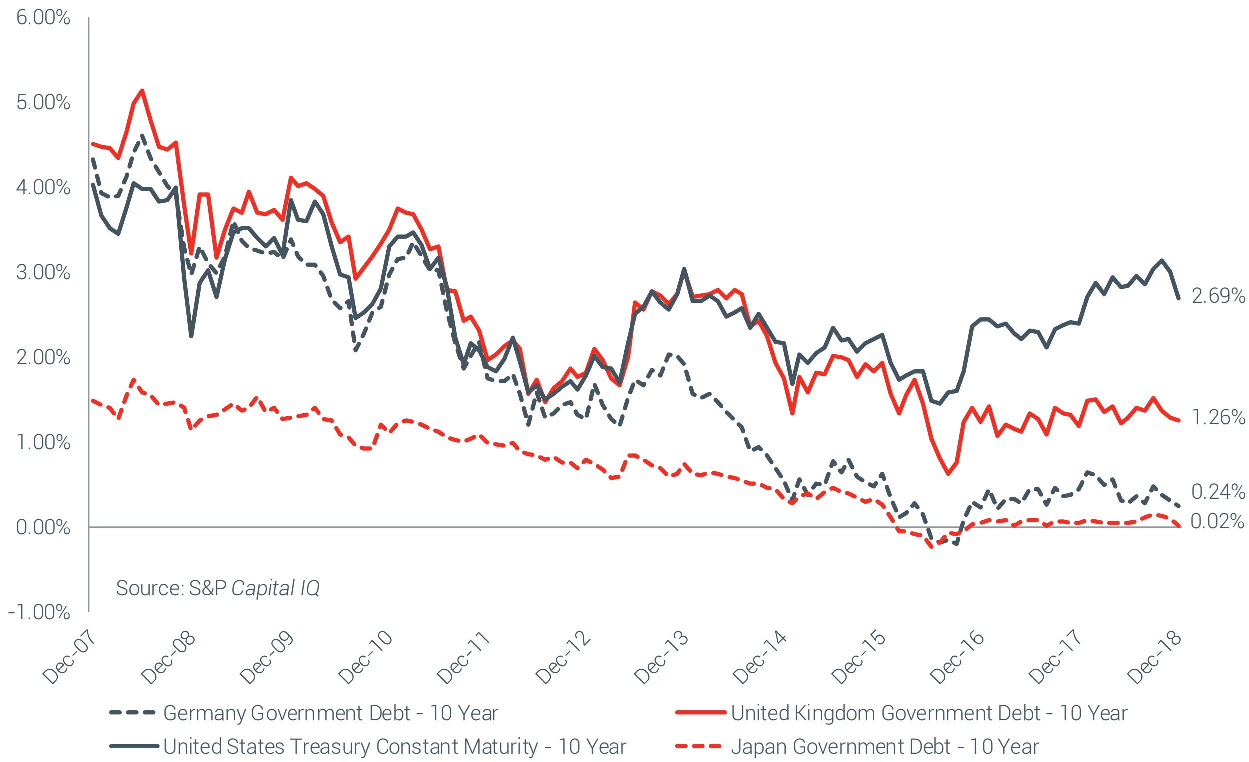
> *"To summarize my argument, the financial and macroeconomic impact of the FOMC's balance sheet policy may well be asymmetric. That is, the size of the balance sheet may have mattered while it was increasing but not while it has been decreasing. With the policy rate near zero, the effects of QE may have been substantial due to signaling effects. Now, with the policy rate well above zero, any signaling effects from balance sheet changes have dissipated. This means that balance sheet shrinkage, or QT, does not have equal and opposite effects from QE. Indeed, one may view the effects of unwinding the balance sheet as relatively minor."*

Global Trends in Interest Rates

When the Fed concluded its third round of QE measures (in October 2014) and signaled that an increase in the target Fed funds rate might be on the horizon, the salient question was what would happen to rates as one of the largest purchasers in the market (the Fed) discontinued its QE operations. All other things held the same, rates would be expected to rise. However, this was not the case. In fact, the yield on 10-year U.S. government bonds dropped from 2.4% at the end of October, to 2.2% at the end of December 2014. Likewise, the 20-year yield dropped from 2.8% to 2.5% over the same period. The behavior of interest rates following the Fed's decision on December 16, 2015 to raise its target range for the Fed funds rate for the first time in nine years was also somewhat puzzling. At first, the yield on 10- and 20-year U.S. government bonds increased, reaching 2.3% and 2.7%, respectively at December 31, 2015. Indeed, yields had already been rising since October 2015, in anticipation of such a rate hike decision. However, with the early 2016 global financial market turmoil and a seeming return to a flight-to-quality psychology, yields declined once more, as can be observed in Exhibit 3.6. In fact, global interest rates went through a rollercoaster ride in 2016, with record low yields being reached by mid-year in some countries, while a year-end reversal pushed rates back to similar levels as of year-end 2015. Up until the beginning of the fourth quarter of 2018, global yields increased reflecting market optimism about global growth. When equity markets sunk in the fourth quarter of 2018 and the prospects of global growth started to falter, flight-to-quality pushed yields lower.

[3.40] Bullard, James, "When Quantitative Tightening Is Not Quantitative Tightening," St. Louis Fed On the Economy blog, Federal Reserve Bank of St. Louis, March 7, 2019, https://www.stlouisfed.org/on-the-economy/2019/march/bullard-when-quantitative-tightening-not-quantitative-tightening. This blog post was based on a speech (with the same title as the blog post) delivered by President Bullard at the 2019 U.S. Monetary Policy Forum, New York, NY on February 22, 2019. A copy of the presentation can be accessed here: https://www.stlouisfed.org/~/media/files/pdfs/bullard/remarks/2019/bullard_usmpf_22_february_2019.pdf?la=en. Also, see Neely, Christopher, "What to Expect from Quantitative Tightening", Economic Synopsis, 2009, Number 8, https://doi.org/10.20955/es.2019.8.

Exhibit 3.6: 10-year Yields on Government Bonds for the United States, United Kingdom, Germany, and Japan December 2007–December 2018



Source of Underlying Data: S&P *Capital IQ* Database. Compiled by Duff & Phelps, LLC.

More recently, even though the Fed has raised short-term interest rates four times during 2018 (a total of 100 b.p.) and started reducing its asset holdings, long-term government bond yields have increased modestly instead. The 20-year U.S. government bond ended 2018 at 2.9% from the 2.6% observed on December 31, 2017. Likewise, 10-year yields ended 2018 at 2.7% from 2.4% observed On December 31, 2017. Why is that?

It may be useful to first distinguish short-term drivers versus long-term trends in interest rates. It is almost undisputed that aggressive monetary policies implemented as a response to the Financial Crisis and flight-to-quality drove long-term interest rates in the U.S. and several other advanced economies to historically low levels. But many economists claim that the current low rate environment is not just a cyclical story and that we can expect to see a lower level of interest rates in the long-term (although possibly not as low as today's). A number of explanatory factors and theories have emerged, some more pessimistic than others.

We do not select which among the various theories is more (or less) correct. Instead, we suggest that valuation specialists read different sources to get acquainted with such theories. A 2015 survey conducted by the Council of Economic Advisers lists various factors that could help explain why long-term interest rates are currently so low, categorized as (i) those that are likely transitory in nature, and (ii) those that are likely longer-lived:[3.41, 3.42]

Factors that Are Likely Transitory

- Fiscal, Monetary, and Foreign Exchange Policies
- Inflation Risk and the Term Premium
- Private-sector Deleveraging

Factors that Are Likely Longer-Lived

- Lower Global Long-run Output and Productivity Growth
- Shifting Demographics
- The Global "Saving Glut"
- Safe Asset Shortage
- Tail Risks and Fundamental Uncertainty

The report concludes that it remains an open question whether the underlying factors linked to the currently low rates are transitory, or whether they imply that the long-run equilibrium for long-term interest rates is lower than before the Financial Crisis.

The bottom line is that the future path of interest rates is uncertain.[3.43] So, for now, we will focus on some factors that may be keeping interest rates still low in the near term and discuss whether one can expect an increase from these levels in the medium-term:

The Fed's balance sheet: The size of the Fed's balance sheet is still considered enormous by historical standards and even though QExit has begun, indications are that the unwinding will be gradual. In addition, the Fed has indicated that its holdings may not get back to the (lower) levels observed prior to the Financial Crisis.

3.41 The Council of Economic Advisers, an agency within the Executive Office of the President of the United States, is charged with providing economic advice to the U.S. President on the formulation of both domestic and international economic policy.

3.42 "Long-Term Interest Rates: A Survey", July 2015. The full report can be accessed here: https://obamawhitehouse.archives.gov/sites/default/files/docs/interest_rate_report_final.pdf. See also "The Decline in Long-Term Interest Rates", July 14, 2015, a short blog article by Maurice Obstfeld and Linda Tesar discussing the various possible drivers of low long-term interest rates listed in the report. The article can be accessed here: https://www.whitehouse.gov/blog/2015/07/14/decline-long-term-interest-rates.

3.43 For another analysis of current long-term interest rates, see Jonathan Wilmot, "When bonds aren't bonds anymore", *Credit Suisse Global Investment Returns Yearbook 2016*, February 2016.

Foreign investor purchases: Another phenomenon that has helped push U.S. interest rates lower over time is that purchases of U.S. government securities by foreign investors remain sizable.[3.44] As indicated in Exhibit 3.4, the total share of U.S. government securities owned by foreign investors remain significant over the last year. Should foreign demand for U.S. government securities decline, it would still likely take years for these holdings to be unwound (especially given the level of globalization of the world economy).[3.45] Notably, there are academic studies that document the significant impact of foreign investors on U.S. interest rates even prior to the onset of the Financial Crisis. One such study (not to be confused with the research cited previously) estimated that absent the substantial foreign inflows into U.S. government bonds, the (nominal) 10-year government bond yield would be 80 b.p. higher using data through 2005.[3.46, 3.47]

Lower real rates: There is a camp of several academics, and even investors, that believes that real rates could be permanently lower for the foreseeable future. Moreover, the concept that investors may be pricing lower real (neutral) rates was reiterated by former Fed Chair Janet Yellen in her press conference following the Fed's September 2017 meeting. Based on evidence from financial markets, a recent academic study has estimated that a drop in the so-called equilibrium or natural rate of interest has contributed about 2% to the general downward trend in yields over the past two decades.[3.48, 3.49]

Loose monetary policies by other Central Banks: There seems to be an expectation that loose monetary policies by other major central banks will continue in the foreseeable future. Since the onset of the Financial Crisis, which was followed by the Euro sovereign debt crisis, major central banks have (i) lowered their benchmark interest rates near or below 0.0% (zero); and (ii) implemented several rounds of unconventional QE measures. For example, deflation fears (and, in some cases, a need to stabilize currency flows) induced a number of major central banks in Europe to adopt unprecedented negative interest rate policies (dubbed "NIRP" in the financial press). In 2016, the Bank of Japan (BOJ) joined the European Central Bank (ECB), as well as the Danish, the Swedish, and the Swiss central banks in adopting this new form of unconventional monetary policies. The following table summarizes the timeline of when NIRP policies were implemented by

[3.44] Source: Treasury International Capital (TIC) System's Portfolio Holdings of U.S. and Foreign Securities – A. "Major Foreign Holders of U.S. Treasury Securities" retrieved from http://www.treasury.gov/resource-center/data-chart-center/tic/Pages/ticsec2.aspx, February 23, 2019.

[3.45] This may already be happening. Over the 2003–2018 time period shown in Exhibit 3.4, the relative share of U.S. government securities held by foreign holders averaged approximately 48%. In more recent years this has been declining, and by the end of 2018 was 40% (down from a high over the 2003–2018 period of 53% reached in 2008).

[3.46] Warnock, Francis E., and Veronica Cacdac Warnock, "International Capital Flows and U.S. Interest Rates," *Journal of International Money and Finance* 28 (2009): 903–919.

[3.47] The impact of foreign financial flows on long-term interest rates is not confined to the U.S. A relatively recent research paper estimates that the increase in foreign holdings of Eurozone bonds between early 2000 and mid-2006 is associated with a reduction of Eurozone long-term interest rates by 1.55%. See: Carvalho, Daniel, and Michael Fidora. "Capital inflows and euro area long-term interest rates." Journal of International Money and Finance 54 (2015): 186-204. Note that the 'euro' was introduced to financial markets on January 1, 1999 as the new 'single currency' of what is now known as the Eurozone.

[3.48] "FOMC: Press Conference on September 20, 2017". The Transcript to this press conference can be found here: https://www.federalreserve.gov/mediacenter/files/FOMCpresconf20170920.pdf.

[3.49] Christensen, Jens HE, and Glenn D. Rudebusch. "A new normal for interest rates? Evidence from inflation-indexed debt." *Review of Economics and Statistics* (2017): 1-46. Also, see Christensen, Jens H. E. & Rudebusch, Glenn D., 2017. "New Evidence for a Lower New Normal in Interest Rates," *FRBSF Economic Letter*, Federal Reserve Bank of San Francisco. Available at: https://www.frbsf.org/economic-research/files/el2017-17.pdf.

central banks in these advanced economies.[3.50]

Central Bank	Region/Coountry	Year
Danish National Bank (DNB)	Denmark	2012
European Central Bank (ECB)	Eurozone	2014
Swiss National Bank (SNB)	Sqitzerland	2015
Riksbank	Sweden	2015
Bank of Japan	Japan	2016

NIRP entails financial institutions paying interest on the liabilities that the central bank issues to them. The main idea of NIRP is to discourage savings while creating incentives for consumers to increase their spending and companies to expand their investment. However, such measures consequently pressure interest rates further downwards. According to an S&P research report:[3.51]

> *"Negative interest rate policy appears to be able to exert downward pressure on the whole yield curve via the portfolio rebalance effect, as security prices, perturbed by the central bank's fixing of one price, adjust to restore equilibrium."*

Negative benchmark interest rates are expected to continue in the Eurozone well past its asset purchase program ends. In Japan, there are no indications that NIRP policies will end any time soon. In addition, in September 2016, the BOJ introduced a new "Quantitative and Qualitative Monetary Easing (QQE) with Yield Curve Control" policy. The BOJ is now targeting the nominal yield of 10-year Japanese government bonds to around 0.0%. No other central bank targets both the level and the slope of the yield curve.[3.52, 3.53]

Asset Purchases: Besides their ultra-low interest rate policies, both the ECB and the BOJ have been conducting large-scale sovereign debt asset purchases for several years. Likewise, the Bank of England in the U.K. and the Riksbank in Sweden have also implemented significant QE measures, although with a small magnitude when compared to the ECB or BOJ's programs.

Asset purchase programs by major central banks have not been limited to government bonds. In some cases, purchases have extended to debt issued by government agencies, regional and local governments, and even corporations. In the case of the BOJ, the QE program also includes significant purchases of equity securities through ETFs (exchange-traded funds).

3.50 Bech, Morten L. and Malkhozov, Aytek, "How Have Central Banks Implemented Negative Policy Rates?" (March 6, 2016). *BIS Quarterly Review* March 2016. Available at: https://www.bis.org/publ/qtrpdf/r_qt1603e.htm. Note that the Riksbank had tried negative policy rates in 2009–2010, but the amount of funds on deposit overnight was immaterial and did not result in negative sovereign bond yields. The Danish central bank maintained a negative certificate of deposit rate from mid-2012 to April 2014, reintroducing negative rates in September 2014. For a historic perspective on negative interest rates in Denmark, also see the chapter entitled "Negative Interest Rates" in Danmarks Nationalbank, *Monetary Review*, 3rd Quarter, Part 1, published on October 23, 2012, and available here: https://www.nationalbanken.dk/en/publications/Documents/2012/10/MON3Q_P1_2012_Negative%20Interest%20Rates.pdf.

3.51 Standard & Poor's Ratings Direct report entitled "Negative Interest Rates: Why Central Banks Can Defy 'Time Preference'", February 3, 2016.

3.52 ECB press conference held March 8, 2018. Visit: https://www.ecb.europa.eu/press/pressconf/2018/html/ecb.is180308.en.html.

3.53 For a list of BOJ's monetary policy decisions, visit: http://www.boj.or.jp/en/mopo/mpmdeci/index.htm/.

In fact, the impact of some QE measures distorted the corporate debt markets considerably. The ECB's Corporate Sector Purchase Programme (CSPP), announced in March 2016, included purchases of euro-denominated *investment-grade* bonds issued by non-financial corporations. In an analyst's estimate, the impact of the ECB's investment-grade corporate debt purchases has cut euro-denominated bond yield spreads on those securities by half, relative to German government bond yields. This effect was seemingly not limited to investment-grade bonds; there was a likely spill-over effect for below-investment-grade (a.k.a., high yield) bonds, which were not included in the ECB program:[3.54]

> *"Since the program began, spreads on European investment-grade bonds over German government bonds have fallen by half to around 0.76 percentage point. That may have pushed down spreads on high-yield bonds, which the ECB doesn't buy, from more than 6 to around 2.5 percentage points, as yield starved investors look elsewhere for returns"*

In 2016 and for the first time, few European non-state-owned companies were able to sell negative yielding bonds. This was considered a temporary distortion and a direct effect of the program.[3.55] More recently, this phenomenon resurfaced as the amount of negative government bond yield increased.[3.56] The pace of ECB's asset purchase program started to slow down in 2018: monthly asset purchases were cut in half from €60 billion to €30 billion beginning January 2018. This new (lower) level of monthly purchases was intended to continue until the end of September 2018, or beyond if necessary.[3.57] In June 2018, the ECB confirmed that the central bank would continue with the same level of net monthly asset purchases until the end of September 2018. However, in that same meeting the ECB announced that it would cut in half the pace of net monthly asset purchases made between October and December 2018, at which point it would stop expanding its balance sheet.[3.58]

Meanwhile in Japan, the BOJ continued to expand its balance sheet in 2018 as inflation is still well below its 2.0% target. In April 2018, Haruhiko Kuroda, the BOJ's governor, mentioned that internal central bank discussions had begun regarding options for exiting the bank's massive "Quantitative and Qualitative Monetary Easing (QQE) with Yield Curve Control" program. However, Mr. Kuroda told the Japanese parliament that it was too early to give any details about the plan. Furthermore, in July 2018 concerns that the BOJ might scale back its monetary policy shook global bond markets. The BOJ was forced to intervene multiple times to calm markets. Governor Kuroda indicated in a press conference that the BOJ would not be diverted from its stimulus program, even as other major central banks (including the Fed, the ECB and even the BOE) reversed their own QE programs.[3.59]

3.54 Mike Bird, "Investors Prepare for the End of ECB's Corporate-Bond Buying," www.wsj.com, updated March 9, 2018.

3.55 Gavin Jackson, "Henkel and Sanofi sell first negative yielding euro corporate bonds," www.ft.com, September 6, 2016.

3.56 Robert Smith, "Negative-yield Bonds: why paying to lend to companies is back" www.ft.com, March 28, 2019.

3.57 For a list of ECB's monetary policy decisions, visit: https://www.ecb.europa.eu/press/govcdec/html/index.en.html.

3.58 ECB: Press Conference on June 14, 2018. To obtain the press conference transcript, visit: https://www.ecb.europa.eu/press/pressconf/2018/html/ecb.is180614.en.html.

3.59 For the discussions in April, see for example: Fujioka, Toru, and Masahiro Hidaka "Bank of Japan Is Discussing Stimulus Exit Options, Says Kuroda." Bloomberg.com, April 3, 2018. Accessible here: https://www.bloomberg.com/news/articles/2018-04-03/kuroda-says-bank-of-japan-is-discussing-future-exit-options. For the events in July and August 2018, see for example: Lewis, Leo, Emma Dunkley, and Robin Wigglesworth. "BoJ intervenes for third time as investors eye policy meeting." ft.com, July 30, 2018. Also, see: Dunkley, Emma and Kana Inagaki. "BoJ shift stirs hopes for Japanese bond trading." ft.com, August 9, 2018.

Both the Bank of England (BOE) in the U.K. and the Riksbank in Sweden have conducted their own sovereign debt asset purchase programs. Although the BOE has now stopped active purchases of U.K. government bonds, it is still maintaining holdings of £435 billion of British government bonds and £10 billion of corporate bonds by reinvesting the proceeds from their holdings. The bank predicts that the unwinding process will take a "number of years and at a gradual and predictable pace".[3.60, 3.61]

The Riksbank ended its monthly asset purchase program in December 2017. The Swedish central bank announced plans to start reducing its balance sheet holdings sometime near the middle of 2019, at which point the unwinding process would begin but at a very gradual pace.[3.62] Therefore, the Swedish central bank will keep reinvesting the proceeds from redeemed government bonds into new ones until such time arrives.

Exhibit 3.7 illustrates the magnitude of the combination of the major central banks' QE programs. In this exhibit, we show how total assets of the Fed, BOJ, ECB, and the BOE have evolved from 2006 until the end of 2018. Note that while Exhibit 3.7 is an *imperfect* measure of sovereign debt instruments held by these central banks because their respective balance sheets will include different types of assets (and different mixes of assets), the sheer quantities of assets is nonetheless striking. In August 2008 just prior to the onset of the Financial Crisis, the combined assets of the Fed, BOJ, ECB, and the BOE amounted to approximately $4.2 trillion; by the end of 2018 the combined assets had nearly *quadrupled* to approximately $15.2 trillion.[3.63]

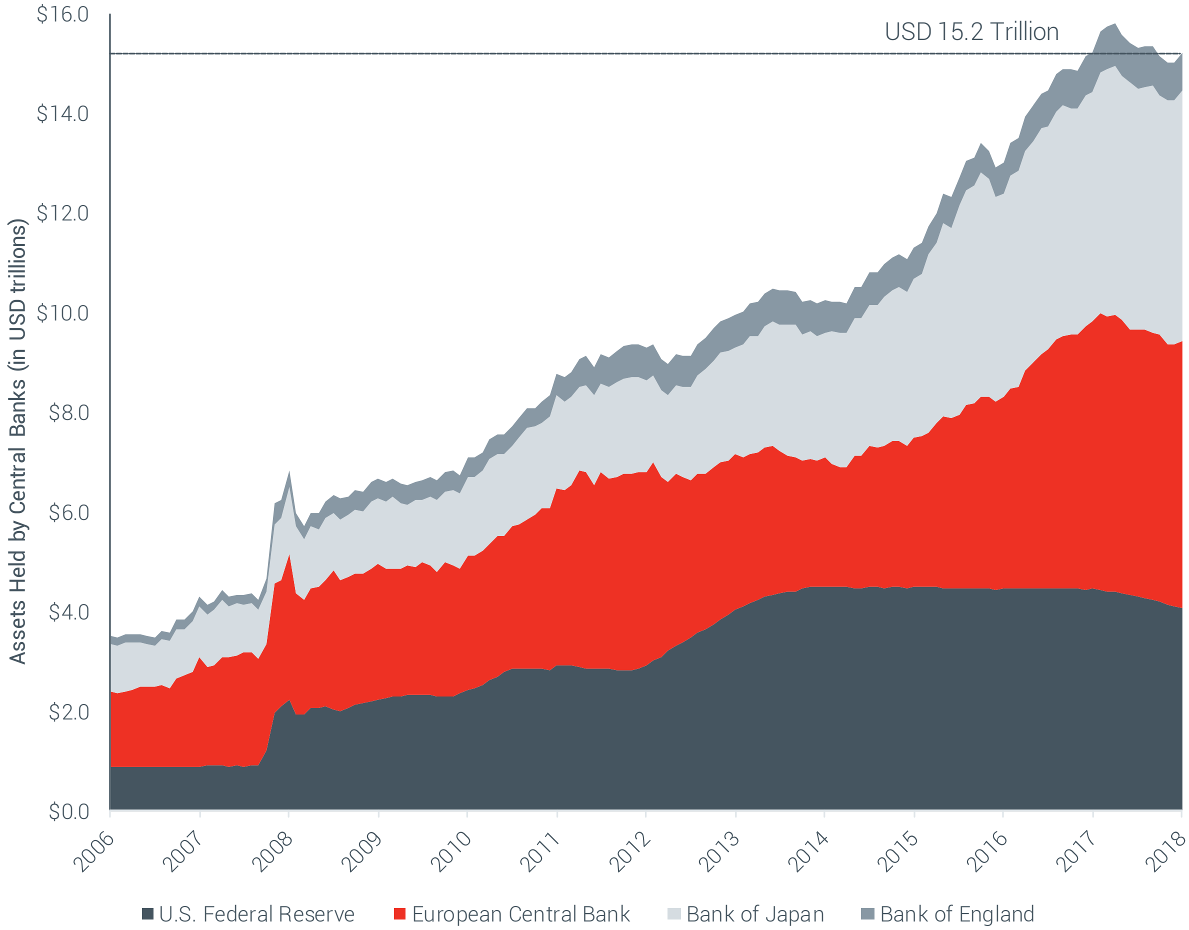
3.60 BOE announced in June 21, 2018 that it will exit its QE program sooner than previously thought but it did not specify a date. See Andy Bruce, "Bank of England brings forward potential timing of QE bond sell-off" June 21, 2018. Available here: https://www.reuters.com/article/us-britain-boe-stimulus/bank-of-england-brings-forward-potential-timing-of-qe-bond-sell-off-idUSKBN1JH2A2.

3.61 For an indication of the possible timing for QExit in the U.K., see "Remit for the Monetary Policy Committee - November 2017", available here: https://www.bankofengland.co.uk/letter/2017/mpc-remit-november-2017.

3.62 For an indication of the possible timing for QExit in Sweden, see speech entitled "The Riksbank's balance sheet: How large should it be in the future?," by Martin Flodén, Deputy Governor of the Riksbank, delivered on April 13, 2018. The speech is available here: https://www.riksbank.se/globalassets/media/tal/engelska/floden/2018/floden-reasonable-for-the-riksbanks-balance-sheet-to-shrink-in-the-long-run. Also, see Nicholas Megaw, "Riksbank to end new bond purchases but maintains dovish outlook," ft.com, December 20, 2017.

3.63 In 2018 the decrease in the balance sheet of the Fed and the BOE was effectively offset by an increase in the balance sheet of the BOJ, and thus the aggregate balance of $15.2 trillion in 2018 was mostly unchanged from 2017's aggregate balance.

Exhibit 3.7: Total Assets Held by Central Banks in the United States, Eurozone, Bank of Japan, and Bank of England (in U.S. Dollars) December 2006–December 2018

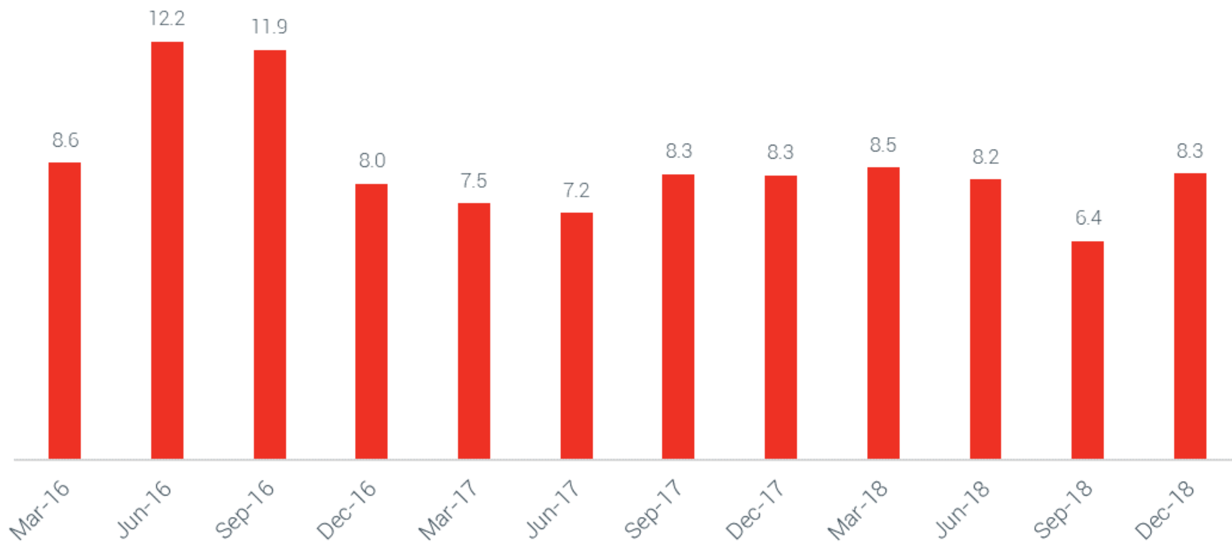


Source of Underlying Data: Federal Reserve Bank of St. Louis Economic Research and the Bank of England. Compiled by Duff & Phelps, LLC.

Sizable increases in major central banks' balance sheets (largely due to holdings of long-term governments securities considered "safe" by investors), along with negative interest rate policies, have continued to exert a downward pressure on global long-term interest rates. According to Bloomberg Barclays Global Aggregate Bond Index, global negative-yielding sovereign debt stood at $8.3 trillion as of the end of December 2018. By the end of the first quarter of 2019, this number reached $10 trillion, a level not seen since September 2017.[3.64] Exhibit 3.8 displays the amount of sovereign debt with negative yields since March 2016, according to Bloomberg.

3.64 Cecile Gutscher, "The $10 Trillion Pool of Negative Debt Is a Late-Cycle Reckoning," Bloomberg.com, March 25, 2019.

Exhibit 3.8: Negative Yielding Sovereign Debt (U.S. Dollars, in Trillions)
March 2016–December 2018



Source of Underlying Data: Bloomberg. Index: Bloomberg Barclays Global Aggregate Negative-Yielding Debt Index.

Unwinding of Assets Purchases: Despite a collective tapering in the pace of asset purchases by the ECB, the BOE, and the Riksbank, the reality is that central banks in the Eurozone, U.K., Sweden, and Japan balance sheets did not change much over the last year. This contrasts with the U.S., where the Fed began a "QExit" program aimed at reducing its balance sheet in October 2017.

The apparent divergence in the monetary policies of the U.S. versus other major economic regions could ultimately make the path towards normalization of U.S. rates *slower* than it would be in the absence of this divergence. With the Fed acting to both decrease its balance sheet and raise rates, while some other major central banks are *not* presently acting to decrease their balance sheets (and actually continuing with QE and/or their NIRP policies), one might expect any increase in U.S. rates to be at least partially offset by increased demand for the relatively more attractive yields of U.S. government securities.

U.S. Government Bond Yields Forecast

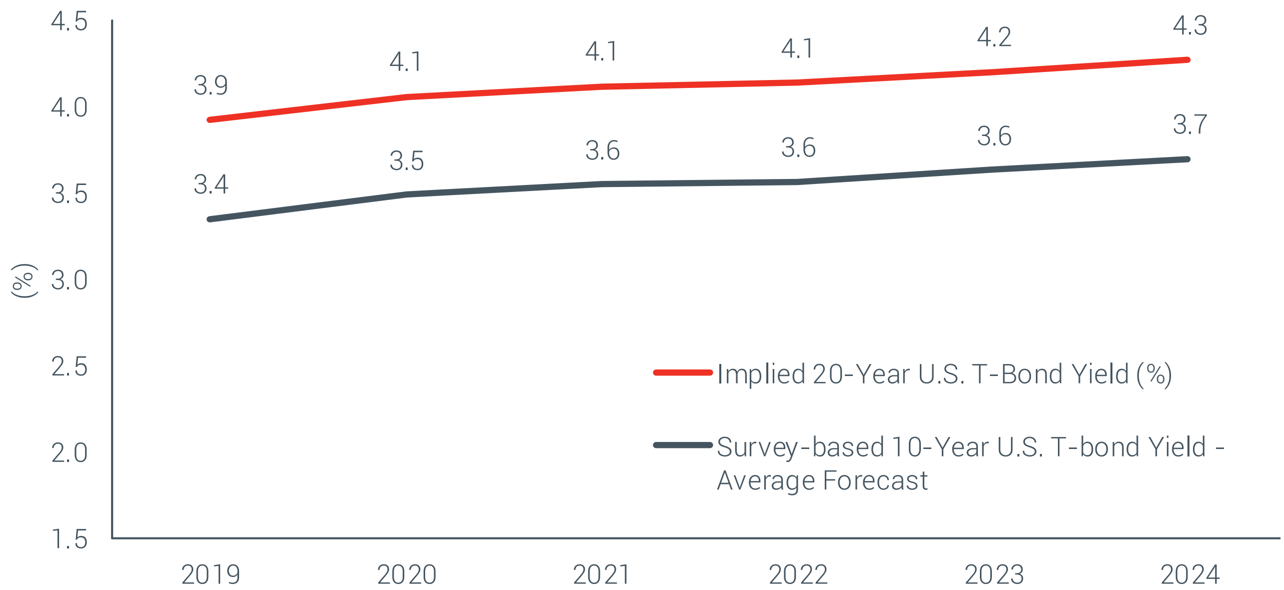
In order to gauge the market expectations about future long-term yields, we compiled consensus forecasts of 10-year U.S. government bond yields from reputable sources published close to year-end 2018.[3.65, 3.66] Exhibit 3.9 displays the average of these forecasts through 2024. We then added a maturity premium to the 10-year yield, to arrive at an implied forecast for the 20-year U.S.

3.65 Sources: "Survey of Professional Forecasters: Fourth Quarter 2018", Federal Reserve Bank of Philadelphia (November 13, 2018); "The Livingston Survey: December 2018", Federal Reserve Bank of Philadelphia (December 15, 2018); "Consensus Forecasts Global Outlook 2018–2028", Consensus Economics Inc. (October 2018); "Consensus Forecasts – A Digest of International Economic Forecasts", Consensus Economics Inc. (December 2018); *Blue Chip Economic Indicators* (October 10, 2018 and December 10, 2018); *Blue Chip Financial Forecasts* (December 1, 2018 and January 1, 2019); S&P *Capital IQ*™ database.

3.66 Not all surveys provided consensus forecasts through 2024. At a minimum, all five sources included forecasts for 2019 and 2020.

government bond yield. Based on this methodology, 20-year yield could reach 4.3% by 2024.[3.67]

Exhibit 3.9: Average forecasted 10-year U.S. government Bond Yield and Implied 20-year U.S. Risk-free Rate (in percentage terms) at year-end 2018



Sources of underlying data: Survey of Professional Forecasters; Livingston Survey; U.S. Consensus Forecasts; *Blue Chip Economic Indicators*; and *Blue Chip Financial Forecasts*; S&P *Capital IQ* database. Compiled by Duff & Phelps, LLC.

The Congressional Budget Office (CBO), a non-partisan agency supporting the U.S. Congressional budgeting process, provides periodic forecasts of the 10-year U.S. government bond yield. Exhibit 3.10 shows the change in the CBO's 10-year yield forecasts between August 2018 and January 2019. The difference between the two forecasts highlights the impact of the change in: (i) the markets' mood and (ii) the direction of the Fed's monetary policy. The August 2018 forecast (solid black line) shows that 10-year yields were expected to increase for the next three years and then revert back to a long-term average of 3.7%.

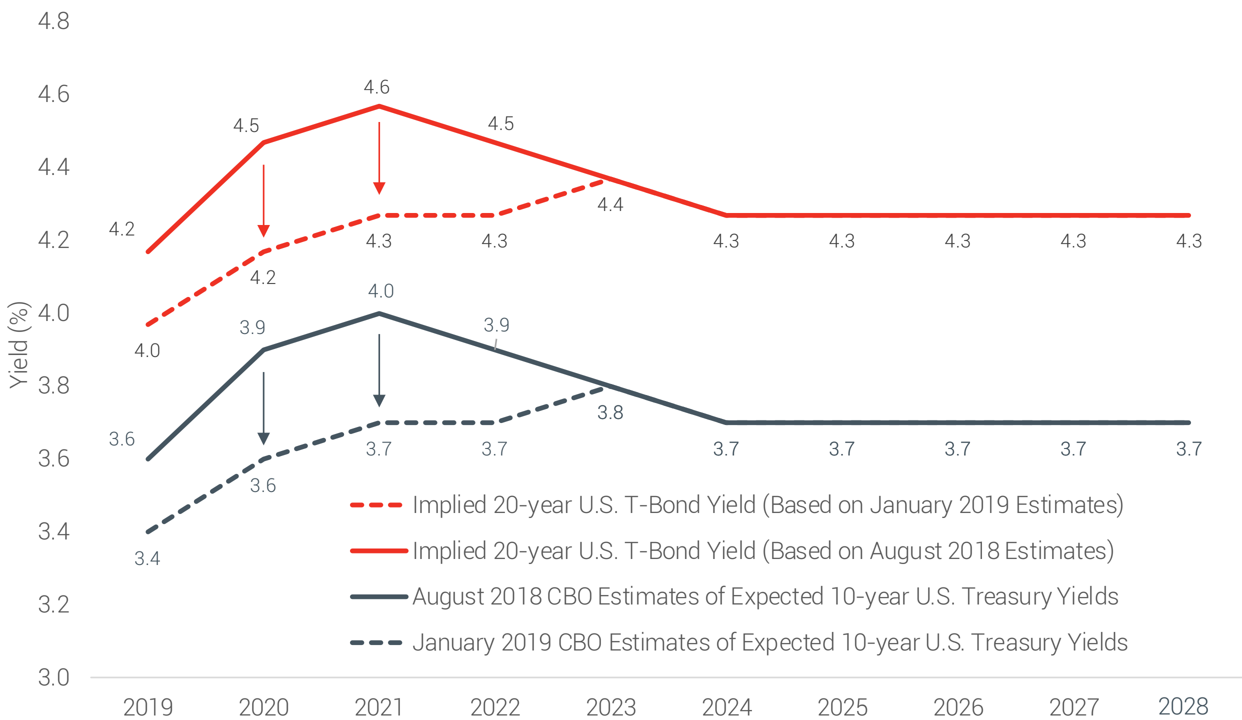
The CBO updated this analysis in January 2019 (dashed black line). The revised January 2019 estimates revealed more modest expectations of 10-year yield increases through 2022 than did the CBO's previous August 2018 estimates. Both August 2018 and revised January 2019 estimates project that 10-year yields will level out at 3.7%, starting in 2024.

We added the maturity premium of 57 b.p. (see footnote 3.67) to the 10-year yield to approximate the implied 20-year yield. The implied future 20-year yield forecasts for August 2018 are represented by the solid red line, where the January 2019 revised implied 20-year are represented

3.67 A maturity premium of approximately 57 b.p. was added to the 10-year yield. This was based on the average yield spread between the 20- and the 10-year U.S. government bond constant maturity bonds from December 2008 through December 2018. Had more recent data been used, when the yield spread has declined to a range of 20 to 30 b.p., would not materially change our main conclusion. While the magnitude of the maturity premium can be debated, using even the most recent 20 to 30 b.p. average yield spread, would imply that at year-end 2018 market participants expected the 20-year yield to reach 3.9% (3.7% + 0.2%) to 4.0% (3.7% + 0.3%) by 2024.

by the dashed red line. These forecasts show that even after the revision to take into consideration the new market and monetary conditions, the 20-year implied forecasts for the next ten years are at least 4% or higher, which is much higher than the 2.87% as of December 31, 2018.

Exhibit 3.10: Average forecasted 10-year U.S. Government Bond Yield and Implied 20-year U.S. Risk-free Rate (in percentage terms) Based on CBO Estimates as of January 2019 and August 2018



Source of underlying data: Congressional Budget Office (CBO), “The Budget and Economic Outlook: 2019 to 2029”, released January 28, 2018.

Methods of Risk-free Rate Normalization

Estimating a normalized risk-free rate can be accomplished in a number of ways, including (i) various "build-up" methods or (ii) simple averaging.

Build-up Methods

The first method of estimating a normalized risk-free rate entails using a simple build-up method, where the components of the risk-free rate are estimated and then added together. Conceptually, the risk-free rate can be (loosely) illustrated as the return on the following two components:[3.68, 3.69]

Risk-free Rate	=	Real Rate	+	Expected Inflation

The first component, the *real rate*, has recently garnered the increased interest of academics, analysts, and financial media alike. The research agenda in this area has been particularly active in the last few years. Until the 2016 edition of the *Valuation Handbook – U.S. Guide to Cost of Capital*, we had relied on certain academic studies that suggested the long-term *"real"* risk-free rate to be somewhere in the range of 1.2% to 2.0%, based on the study of inflation swap rates and/or yields on long-term U.S. government bond Inflation Protected Securities (TIPS).[3.70, 3.71, 3.72]

[3.68] This is a simplified version of the "Fisher equation", named after Irving Fisher. Fisher's "The Theory of Interest" was first published by Macmillan (New York), in 1930. To be more precise, nominal interest rates incorporate not just inflation expectations, but also compensation for bearing inflation risk. In other words, inflation compensation economically consists of two components: expected inflation (the rate of inflation over the term of the risk-free investment) plus an inflation risk premium (the risk that expected inflation will increase or decrease relative to expected inflation). In essence, the inflation risk premium is related to the dispersion of forecasts of market participants around the expected future inflation rate. The greater the dispersion, the greater the uncertainty, the higher the premium demanded by investors to compensate for this risk. The theory has long assumed that the real rate component was fixed and most (if not all) of the variation in nominal yield was due to inflation. There is growing body of literature that studies the decomposition of inflation volatility from total nominal bonds volatility and factors affecting the former. Earlier studies found that inflation risk drove most of the variation in nominal yields; for example, Campbell, John Y., and John Ammer. "What moves the stock and bond markets? A variance decomposition for long-term asset returns." *The Journal of Finance* 48, no. 1 (1993): 3-37. A more recent paper finds that only between 10%-20% of yield volatility is due to variation in expected inflation; see: Duffee, Gregory R. "Expected inflation and other determinants of Treasury yields." *The Journal of Finance* 73, no. 5 (2018): 2139-2180.

[3.69] In this current analysis, we are assuming the inflation risk premium on a long-term government security is canceled out by a Liquidity premium. Indeed, changes in the inflation risk premium may be empirically difficult to distinguish from changes in expected inflation and liquidity premium. This has led some researchers to assume that the inflation risk premium is more likely offset by the liquidity premium present in U.S. Treasury Inflation Protected Securities (TIPS) yields. For a recent survey of inflation risk premia and models see: Kupfer, Alexander. "Estimating inflation risk premia using inflation-linked bonds: A review." *Journal of Economic Surveys* 32, no. 5 (2018): 1326-1354. Bauer, Michael D., "A New Conundrum in the Bond Market?", *FRBSF Economic Letter* 2017–34 (November 2017); Berardi, Andrea and Plazzi, Alberto, Inflation Risk Premia, Yield Volatility and Macro Factors (January 10, 2018), Swiss Finance Institute Research Paper No. 18-13.

[3.70] TIPS are marketable securities whose principal is adjusted relative to changes in the Consumer Price Index (CPI).

[3.71] Haubrich, Joseph, George Pennacchi, and Peter Ritchken, "Inflation Expectations, Real Rates, and Risk Premia: Evidence from Inflation Swaps," *Review of Financial Studies* Vol. 25 (5) (2012): 1588–1629. The results of the authors' work are updated on a monthly basis and published in the Federal Reserve Bank of Cleveland's website. The "Inflation Expectations" monthly series published in the "Inflation Central" section of the website, contains an expected 10-year Real Risk Premia (as predicted by the model), which would be a proxy for the maturity premium of the 10-year real yield over the short-term real risk-free rate. For example, in December 2018, this expected 10-year Real Risk Premium was 1.2%. The "Inflation Central" is located here: https://www.clevelandfed.org/en/our-research/inflation-central.aspx.

[3.72] For other research used as support for real rate estimates prior to 2016, see Andrew Ang and Geert Bekaert "The Term Structure of Real Rates and Expected Inflation," The Journal of Finance, Vol. LXIII (2) (April 2008); and Olesya V Grishchenko and Jing-zhi Huang "Inflation Risk Premium: Evidence From the TIPS Market," *The Journal of Fixed Income*, Vol. 22 (4) (2013): 5–30.

Fast forward to the end of 2018, and we now have several other studies from which we draw an estimate for real rates. As highlighted earlier in this chapter, academic researchers and economic analysts have proposed a number of explanations for the secular (i.e., not cyclical or temporary) decline in global real interest rates, which they argue precedes the onset of the Financial Crisis. Some of those studies have proposed new measures to estimate the real rate for the United States and other countries. Based on those studies, we are now relying on a long-term real rate estimate of 0.0% to 2.0% for the United States, which represents a lower range relative to Duff & Phelps analyses conducted prior to 2016.[3.73, 3.74]

The second component, *expected inflation*, can also be estimated in a number of ways. Monetary policymakers and academics have been monitoring several measures of market expectations of future inflation. One method of estimating long-term inflation is to take the difference between the yield on a 20-year U.S. government bond and the yield on a 20-year U.S. TIPS. This is also known as the "breakeven inflation".[3.75] This calculation is shown in Exhibit 3.11 over the time period July 2004 –December 2018. Over this period, the average monthly breakeven long-term inflation estimate using this method was 2.2% (3.6% government bond yield – 1.4% TIPS yield). The spot breakeven inflation was 1.8% at the end of 2018.[3.76]

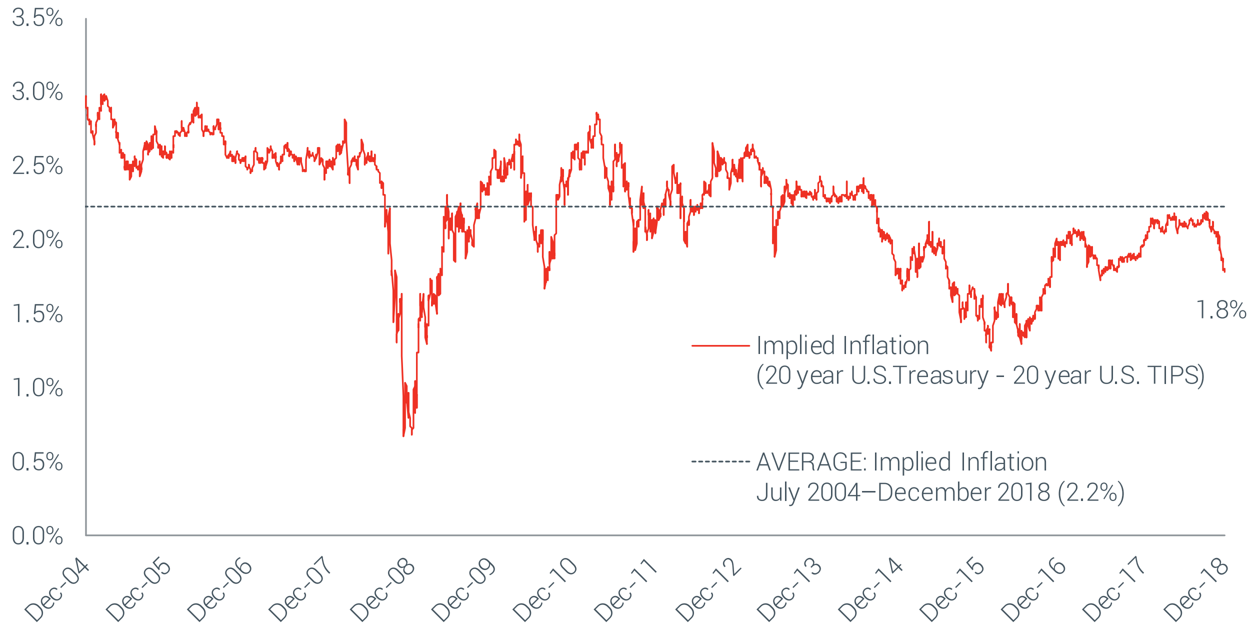
3.73 Pescatori, Andrea, and Mr Jarkko Turunen. Lower for longer: neutral rates in the United States. No. 15-135. International Monetary Fund, 2015.; Kiley, Michael T., "What Can the Data Tell Us About the Equilibrium Real Interest Rate?", *Finance and Economics Discussion Series* 2015–077. Washington: Board of Governors of the Federal Reserve System (August 2015); Lubik, Thomas A. and Christian Matthes "Calculating the Natural Rate of Interest: A Comparison of Two Alternative Approaches", *Richmond Fed Economic Brief* (October 2015); Johannsen, Benjamin K. and Elmar Mertens (2016), "The Expected Real Interest Rate in the Long Run: Time Series Evidence with the Effective Lower Bound", FEDS Notes, Washington: Board of Governors of the Federal Reserve System, February 9; Lansing, Kevin J., "Projecting the Long-Run Natural Rate of Interest", *FRBSF Economic Letter* 2016–25 (August 2016); Hamilton, James, Ethan Harris, Jan Hatzius, and Kenneth West, "The Equilibrium Real Funds Rate: Past, Present and Future", *IMF Economic Review*, November 2016, Vol. 64, Issue 4, p. 660–707; Holston, Kathryn, Thomas Laubach, and John C. Williams, "Measuring the natural rate of interest: International trends and determinants", *Journal of International Economics*, Volume 108, Supplement 1, 2017, Pages S59-S75; Del Negro, Marco and Giannone, Domenico and Giannoni, Marc P. and Tambalotti, Andrea (2017-05-11), "Safety, Liquidity, and the Natural Rate of Interest", *FRB of NY Staff Report* No. 812; Sichel, Daniel E. & Wang, J. Christina (2017), "The equilibrium real policy rate through the lens of standard growth models", *Current Policy Perspectives* 17-6, Federal Reserve Bank of Boston; Lunsford, Kurt G., and Kenneth D. West. "Some evidence on secular drivers of US safe real rates" No. w25288. National Bureau of Economic Research, 2018.; Wieland, V. (2018). Chapter 2 The Natural Rate - Section One - R- Star: The Natural Rate and Its Role in Monetary Policy; *In the Structural Foundations of Monetary Policy* (pp. 45-61). Hoover Institution Press, Stanford University; Viktors Ajevskis, (2018). "The Natural Rate of Interest: Information Derived from a Shadow Rate Model," Working Papers 2018/02, Latvijas Banka; Fiorentini, Gabriele, Galesi, Alessandro, Perez-Quirós, Gabriel and Sentana, Enrique, (2018), "The rise and fall of the natural interest rate," No 1822, Working Papers, Banco de España; Christensen, Jens HE, and Glenn D. Rudebusch. "A new normal for interest rates? Evidence from inflation-indexed debt." *Review of Economics and Statistics* (2017): 1-46; Lewis, Kurt F., and Francisco Vazquez-Grande (2017). "Measuring the Natural Rate of Interest: Alternative Specifications," *Finance and Economics Discussion Series* 2017-059. Washington: Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2017.059.

3.74 We continue to also rely on the results of Haubrich et al (2012) and Holston et al. (2017) work, which are updated on a monthly basis and published in the Federal Reserve Bank of Cleveland's website and the Federal Reserve Bank of New York's website, respectively.

3.75 Breakeven inflation is based on the differential between nominal and TIPS yields with equivalent maturity.

3.76 Note that several studies have documented that the breakeven inflation has not been a good predictor for inflation expectations. The differential between nominal and real rates is not only complicated by a liquidity premium, but also by the potential presence of the inflation risk premium, with both of these premiums varying through time. For more details, see aforementioned research focused on estimating inflation risk premia. Also, refer to the following research highlighting the shortcomings of using breakeven inflation as an indication of long-term inflation: Bauer, Michael D., and Glenn D. Rudebusch (2015), "Optimal Policy and Market-Based Expectations", *FRBSF Economic Letter* 2015-12 (April 13); and Christensen, Jens H.E. and Jose A. Lopez (2016), "Differing Views on Long-Term Inflation Expectations", FRBSF Economic Letter 2016-11 (April 4).

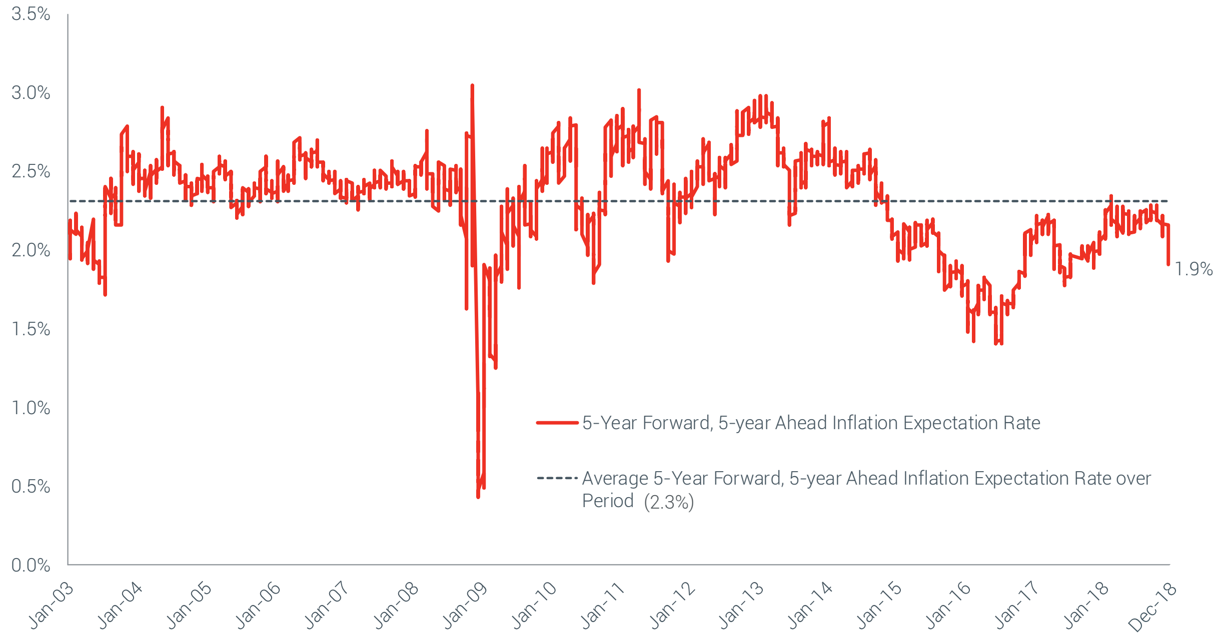
Exhibit 3.11: Breakeven Long-term Inflation Estimate
(20-year U.S. Government Bond Yield – 20-year TIPS Yield) July 2004–December 2018



Source of underlying data: 20-year U.S. Government bond series and 20-year TIPS series, Board of Governors of the Federal Reserve System website at: http://www.federalreserve.gov/releases/h15/data.htm. Calculated by Duff & Phelps, LLC.

An alternative perspective for breakeven inflation measures of long-term inflation expectation is based on the "five-year-forward, five-year ahead" inflation rate. This information is extracted from interest rate swap markets and measures what investors expect inflation will be on average over a five-year period, starting five years from now (or the measuring date). These rates are frequently used by financial markets to measure long-term inflation expectations, but again it is just another form of breakeven inflation. Exhibit 3.12 (next page) shows the five-year-forward, five-year-ahead inflation rate over the January 2003–December 2018 time period. Over this period, the average monthly five-year-forward, five-year ahead inflation rate was 2.3%. Five-year-forward, five-year ahead inflation was 1.9% at the end of 2018.

Exhibit 3.12: 5-Year-Forward, 5-Year-Ahead Inflation Expectation Rate
January 2003–December 2018



Source of underlying data: 5-Year-Forward, 5-Year-Ahead Inflation Expectation Rate, Board of Governors of the Federal Reserve System website at: http://www.federalreserve.gov/releases/h15/data.htm. Calculated by Duff & Phelps, LLC.

Additionally, in the U.S. there are a number of well-established surveys providing consensus estimates for expected inflation. One academic study examined various methods for forecasting inflation over the period 1952–2004 and found that surveys significantly outperform other forecasting methods.[3.77] Exhibit 3.13 outlines some of the most prominent surveys in this area. Altogether, the year-end 2018 estimates of longer-term inflation range from 2.1% to 2.5%.

[3.77] Ang, A., G. Bekaert, and M. Wei. "Do macro variables, asset markets, or surveys forecast inflation better?" Journal of Monetary Economics. 54, 1163-1212.

Exhibit 3.13: Long-term Expected Inflation Estimates Year-end 2018 (approx.)

Source	Estimate (%)
Livingston Survey (Federal Reserve Bank of Philadelphia)	2.2
Survey of Professional Forecasters (Federal Reserve Bank of Philadelphia)	2.2
Blue Chip Financial Forecasts	2.2
Blue Chip Economic Indicators	2.2
Consensus Economics	2.2
Cleveland Federal Reserve	2.1
Aruoba Term Structure of Inflation Expectations	2.2
University of Michigan Survey 5-10 Year Ahead Inflation Expectations	2.5
Range of Expected Inflation Forecasts	2.1% to 2.5%

Sources of underlying data: "The Livingston Survey: December 2018," Federal Reserve Bank of Philadelphia (December 15, 2018); "Survey of Professional Forecasters: Fourth Quarter 2018," Federal Reserve Bank of Philadelphia (November 13, 2018); *Blue Chip Financial Forecasts* (December 1, 2018 and January 1, 2019); *Blue Chip Economic Indicators* (October 10, 2018 and December 10, 2018); "Consensus Forecasts Global Outlook 2018–2027", Consensus Economics Inc. (October 2018); "Consensus Forecasts – A Digest of International Economic Forecasts", Consensus Economics Inc. (December 2018); Federal Reserve Bank of Cleveland (estimates as of December 2018); Philadelphia Federal Reserve, Aruoba Term Structure of Inflation Expectations (estimates as of December 2018); the University of Michigan Inflation Expectations, December 2018.

Adding the estimated ranges for the "real" risk-free rate (0.0% to 2.0%) and longer-term inflation (2.1% to 2.5%) together produces an estimated normalized risk-free rate range of 2.1% to 4.5%, with a midpoint of 3.3% (rounded) (see Exhibit 3.14).

Exhibit 3.14: Estimated Range of Normalized Risk-free Rate Using Simple Build-up Method

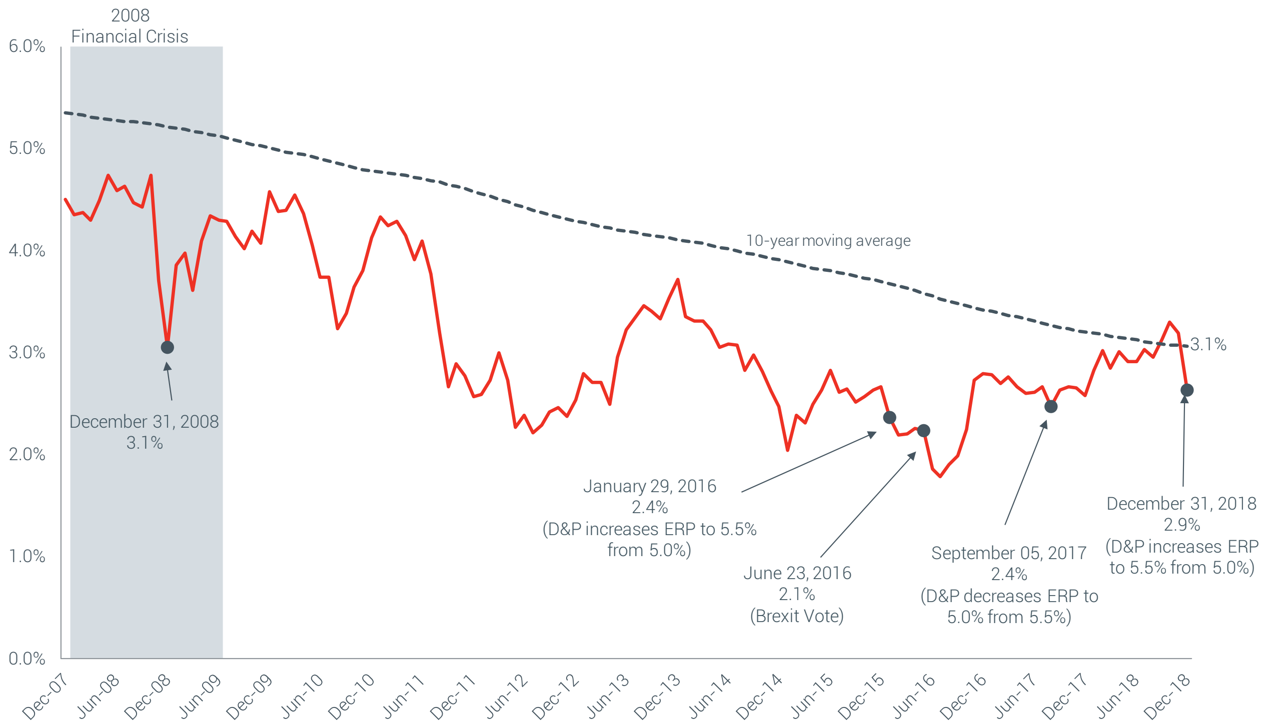
Range of Estimated Long-Term Real Rate	0.0% to 2.0%
Range of Estimated Expected Inflation Forecasts	2.1% to 2.5%
Range of Estimated Long-term Normalized Risk-free Rate	2.1% to 4.5%
Midpoint	3.3%

Contrary to some expectations of higher inflation after the enacting of the U.S. tax cuts in December 2017, inflation has remained subdued and consensus long-term inflation expectations by the end of 2018 continued to be well anchored in the 2.1% to 2.5% range (see Exhibit 3.13). However, with the strong job market and the decision of the Fed to pause its interest rate hikes, inflationary pressure might build up during the year 2019. We will continue to monitor the trajectory of inflation expectations and consequent effects on the normalized long-term risk-free rate.

Long-term Averages

The second method of estimating a normalized risk-free rate entails calculating averages of yields to maturity on long-term government securities over various periods. This method's implied assumption is that government bond yields revert to the mean. In Exhibit 3.15, the solid red line is the spot yield on a 20-year U.S. government bond (December 2007–December 2018), whereas the dashed gray line shows the 10-year moving average of the monthly yield of the 20-year U.S. government bond since the Financial Crisis and ending on December 31, 2018. During this period, the 20-year yield surpassed its 10-year moving average for the first time in September 2018, a sign that perhaps long-term interest rates were finally moving upwards to historical levels. However, during the fourth quarter of the year, the economic outlook changed (a discussion of the economic outlook during 2018 will follow later in this chapter) and the 20-year yield started to decline again, ending the year at 2.9% below its trailing moving average of approximately 3.1%. An issue with using historical averages, though, is selecting an appropriate comparison period that can be used as a reasonable proxy for the future.

Exhibit 3.15: Spot and Average Yields on 20-year U.S. Government
December 2007–December 2018



Source of underlying data: 20-year U.S. government bond series. Board of Governors of the Federal Reserve System website at: http://www.federalreserve.gov/releases/h15/data.htm. 10-year moving average measured as the average of 120 month-end yields on a rolling basis.

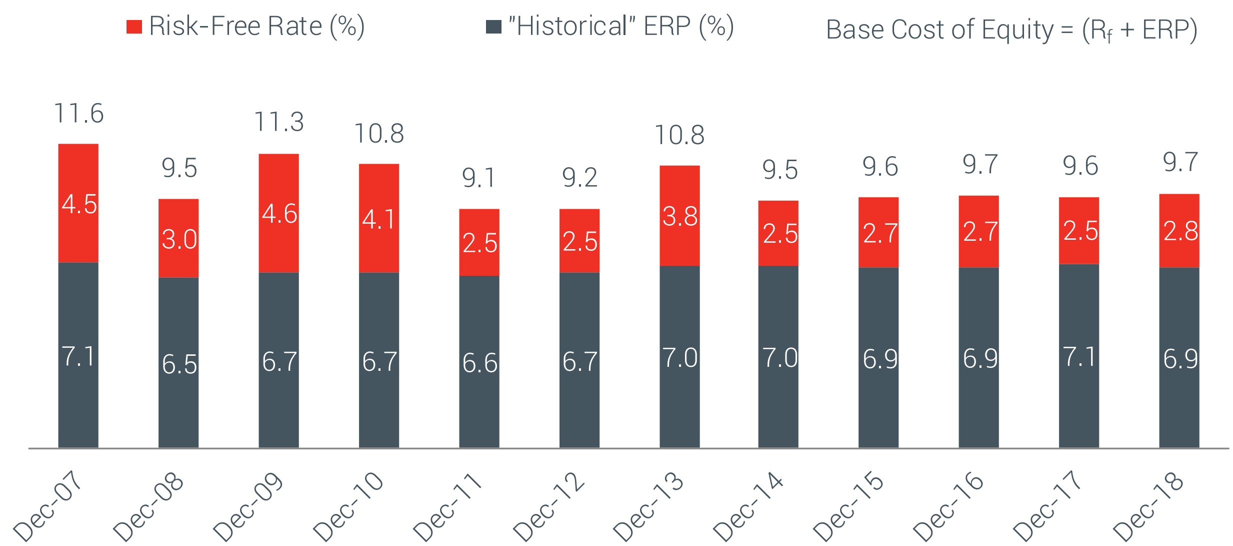
Spot Yield or Normalized Yield?

Should the valuation analyst use the current market yield on risk-free U.S. government bonds or use a "normalized" risk-free yield when estimating the cost of equity capital?

As stated earlier, in most circumstances we would prefer to use the "spot" yield on U.S. government bonds available in the market as a proxy for the U.S. risk-free rate. However, during times of flight-to-quality and/or high levels of central bank intervention, those lower observed yields imply a lower cost of capital (all other factors held the same) – just the opposite of what one would expect in times of relative economic distress – so a "normalization" adjustment may be considered appropriate. By "normalization" we mean the current expected real rate plus the current expected inflation. *If spot yield-to-maturity were used at these times, without any other adjustments, one would arrive at an overall discount rate that is likely inappropriately low vis à-vis the risks currently facing investors.*

Exhibit 3.16 shows the potential problems of simply using the spot yield-to-maturity on 20-year U.S. government bonds in conjunction with unadjusted U.S. historical equity risk premia. Data is displayed for year-end 2007 through year-end 2018. For example, in December 2008 at the height of the Financial Crisis (when risks were arguably at all-time highs), the 1926–2008 historical ERP added to the spot 20-year yield would result in a base cost of equity capital of 9.5%. In contrast, the base cost of equity was 11.6% at year-end 2007, implying that risks were actually *higher* at the end of 2007 than at the end of 2008. From both a theoretical and practical standpoint, the reality is that investors likely perceived risks to be much higher in December 2008 relative to December 2007. This demonstrates that a mechanical application of the data can produce nonsensical results.[3.78]

Exhibit 3.16: Spot 20-year U.S. government Yield in Conjunction with Unadjusted "Historical" Equity Risk Premium 2007–2018



Source of underlying data: Morningstar, Inc. Used with permission. All rights reserved. Calculations by Duff & Phelps. Exhibit 3.16 is constructed using the long-horizon "historical" ERP, and the SBBI® long-term U.S. government bond yield series, as published in the former 2008–2013 Morningstar *SBBI® Valuation Yearbook*, the 2014–2018 *Valuation Handbook – U.S. Guide to Cost of Capital*, and, starting in 2018, the online Duff & Phelps Cost of Capital Navigator platform. All rights reserved. Used with permission. Full-precision decimals were used in the calculations; some values may not add up due to rounding issues.

Adjustments to the ERP or to the risk-free rate are, in principle, a response to the same underlying concerns and should result in broadly similar costs of capital. Adjusting the risk-free rate in conjunction with the ERP is only one of the alternatives available when estimating the cost of equity capital.

For example, one could use a spot yield for the risk-free rate, but *increase* the ERP or other adjustment to account for higher (systematic) risk. If the valuation analyst chooses to use the spot yield to estimate the cost of capital during periods when those yields are less than "normal," the valuation analyst must use an estimated ERP that is *matched* to (or implied by) those *below-normal* yields. However, we note that the most commonly used data sources for ERP estimates are long-term series measured when interest rates were largely not subject to such market intervention. Using those data series with an abnormally low spot yield creates a mismatch.

Alternatively, if the valuation analyst chooses to use a normalized risk-free rate in estimating the cost of capital, the valuation analyst must again use an estimated ERP that is *matched* to those *normalized* yields. Normalizing the risk-free rate is likely a more direct (and more easily

[3.78] More detailed information on historical ERPs can be found later in this chapter.

implemented) analysis than adjusting the ERP due to a *temporary* reduction in the yields on risk-free securities, while *longer-term* trends may be more appropriately reflected in the ERP.

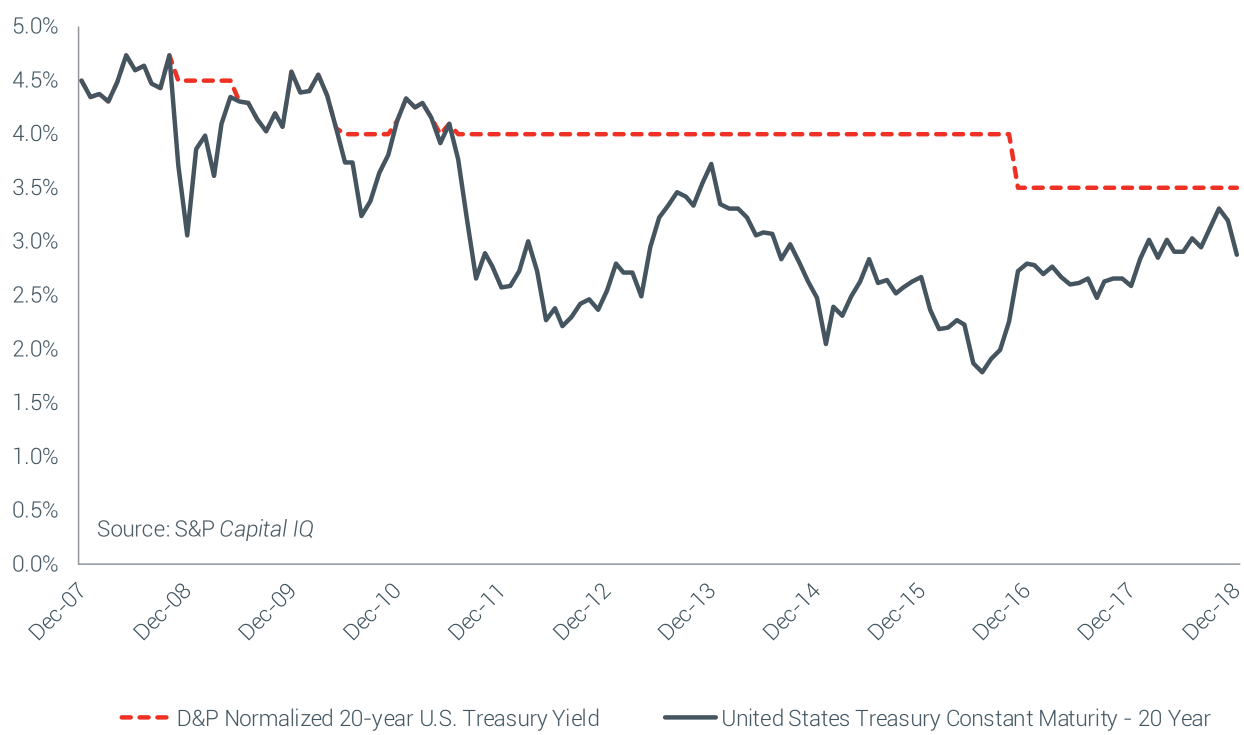
Concluded Normalized Risk-free Rate

In the examples herein, we are using data as of December 2018.

We examined interest rates for the months since the Financial Crisis began. We also estimated a "normalized" yield using a build-up model (3.3%; see Exhibit 3.14), corroborated by a long-term trailing average (3.1%; see Exhibit 3.15). However, the strong labor market and relatively high economic growth may create additional inflationary pressures. Based on the combination of these quantitative and qualitative factors, we have concluded a 3.5% as a reasonable recommended normalized risk-free rate of return as of December 31, 2018.

Exhibit 3.17 is a graphical illustration of both the daily "spot" long-term U.S. risk-free rate (using 20-year U.S. government bond yields), and the Duff & Phelps recommended "normalized" long-term U.S. risk free rate from January 1, 2008 through December 31, 2018. The solid gray line in Exhibit 3.17 represents the "spot" rate. The dashed red line in Exhibit 3.17 is the Duff & Phelps suggested risk-free rate, which has been the "spot" rate during certain periods (when the gray line overlaps with the red line in the graph) and has been a "normalized" rate during certain periods (the dashed red horizontal lines in the graph).

Exhibit 3.17: Spot 20-year U.S. Government Bond Yield vs. Duff & Phelps Recommended Risk-Free Rate (which can be "Spot" or "Normalized", Depending on the conditions at the Time)
December 2007–December 2018



As of December 31, 2018, the Duff & Phelps recommended ERP is 5.5% (discussed in the next section), implying a base U.S. cost of equity capital of 9.0% (3.5% + 5.5%) at that time.[3.79]

Exhibit 3.29 at the end of this chapter provides a summary of both the Duff & Phelps recommended equity risk premium and the accompanying risk-free rate (which can be "spot" or "normalized", depending on conditions at the time) over the time period of December 2007 through December 2018. Please note that the Duff & Phelps recommended ERP is developed in *relation to* (and should be used in *conjunction with*) the risk-free rate it was developed in relation to (either "spot" or "normalized", as indicated in Exhibit 3.29).

Equity Risk Premium [3.80]

The ERP (often interchangeably referred to as the *market risk premium*) is defined as the extra return (over the expected yield on risk-free securities) that investors expect to receive from an investment in a diversified portfolio of common stocks, typically represented by a broad-based stock market index (e.g., S&P 500 Index, NYSE Index, MSCI All Country World Index, etc.).

In a recent academic study, the authors conclude that "The ERP is widely acknowledged as the most important variable in finance."[3.81]

The ERP (or notational RP_m) is defined as:

$$RP_m = R_m - R_f$$

Where:

RP_m	=	Equity risk premium
R_m	=	Expected return on a diversified portfolio of equity securities, most often measured as the S&P 500 Index or the NYSE Index (for the U.S. market)
R_f	=	Expected risk-free rate

The ERP is a forward-looking concept. It is an expectation as of the valuation date for which no market quotes are directly observable. The ERP is a function of expected returns on a diversified portfolio of equities minus an expected yield on a risk-free security to which it is compared over a specified time period.

3.79 From January to March 2019, the spot 20-year yield has ranged from 2.6% to 3.0%. Duff & Phelps will continue to monitor risk-free rates and other cost of capital inputs very closely. If and when (i) long-term spot yields increase to a level that approaches the Duff & Phelps recommended U.S. normalized risk-free rate (e.g., differences are less than 50 b.p.), and (ii) there is evidence that this increase in spot yields is not transitory, we will then consider recommending a return to using the spot rate as the basis for the risk-free rate to be used in conjunction with our recommended U.S. ERP.

3.80 Excerpted in part from Pratt and Grabowski, op.cit.: Chapters 8 and 8A and updated through March 31, 2019.

3.81 Siegel, Laurence B., "The Equity Risk Premium: A Contextual Literature Review", *CFA Institute Research Foundation Volume 12, Issue 1*, November 2017, ISBN: 978-1-944960-31-5: 1.

The ERP can be thought of in terms of an *unconditional* ERP (i.e., the long-term average through the business cycle) and a *conditional* ERP based on current levels of the stock market and economy relative to the long-term average.[3.82]

In this chapter, we are addressing returns of publicly traded stocks relative to an expected yield on a risk-free security. The ERP in conjunction with the risk-free rate, either normalized or actual, also establishes a beginning benchmark for estimating the appropriate discount rates for securities of closely-held businesses.

Estimating the Equity Risk Premium

There is no universally accepted methodology for estimating the ERP. A wide variety of premiums are used in practice and recommended by academics and financial advisors. These differences are often due to differences in how ERP is estimated.

Generally, we can categorize approaches for estimating the ERP as either an *ex post* approach or an *ex ante* approach.

For example, some valuation analysts define expected returns on common stocks in terms of averages of realized (historical) single-period returns while others define expected returns on common stocks in terms of realized multi-year compound returns. These are *ex post* approaches.

Other valuation analysts estimate the ERP using the returns on the diversified portfolio implied by expected (future) stock prices or expected dividends. These are *ex ante* approaches.

From an investment return perspective, the ERP is typically defined as the expected average annual compound return on a diversified portfolio of equity securities, most often measured as the S&P 500 Index for the U.S. market, minus the expected return on a risk-free security.

If one is using *historical* risk premiums (sometimes called a "long-term historical ERP") as an estimator of *future* risk premiums (an *ex post* approach), the geometric average of realized returns is the estimator one should use in compounding future returns to estimate future wealth. But if one is using historical risk premiums as the estimator of the ERP for use in cost of capital models intended for discounting expected cash flows, the most widely used statistic is the arithmetic average of realized risk premiums.[3.83]

Even if one is simply looking forward at prospective returns for the S&P 500 and the implied ERP (an *ex ante* approach), the arithmetic average equivalent of the implied ERP is a better statistic to use in cost of capital models intended for discounting expected cash flows.

Historical return and risk premium data are often expressed in terms of one-year returns. In both this chapter and in the Cost of Capital Navigator, we have attempted to convert varying indications of the ERP such that they are measured in a consistent framework (e.g., a statistical estimator of the ERP in excess of 20-year U.S. government bonds).

[3.82] Robert D. Arnott, "Theoretical Foundations: Discussion", Equity Risk Premium Forum, AIMR (November 8, 2001): 27.

[3.83] For a complete discussion of the use of the arithmetic average compared to the geometric average of realized risk premiums, see *Cost of Capital: Applications and Examples* 5th ed, Appendix 8A.

Ex Post Approaches

While a valuation analyst can observe premiums realized over time by referring to historical data (i.e., realized risk premium approach or *ex post* approach), such realized premium data do not necessarily represent the ERP expected in those prior periods, nor do they represent the current ERP estimate. Rather, to the extent that realized premiums on the average equate to expected premiums in prior periods, such samples *may be* representative of current expectations. But to the extent that prior events that were not expected to occur caused realized returns to differ significantly from prior expectations, such samples need to be adjusted to remove the effects of these nonrecurring events. One needs to understand which events might be considered nonrecurring and then adjust the data associated with such events, in order to improve the predictive power of the historical sample.

Further, *ex post* realized returns on stocks and realized risk premiums will be affected by differences between expected inflation at the time when an ERP estimate was made and the realized inflation subsequent to the date of the estimate. This difference will cause *ex post* stock returns and *ex post* risk premiums to differ from the ERP that had been anticipated (or estimated) in prior periods.

Ex Ante Approaches

Valuation analysts can derive forward-looking estimates for the ERP from forward-looking data at the time of the analysis (*ex ante* approach).[3.84] We can generally categorize four types of forward-looking data used in estimating the expected returns on a diversified portfolio of equities and, in turn, the ERP:

i. Data on the underlying expectations of growth in overall corporate earnings and dividends for the benchmark market index (the so called "top-down" approaches).

ii. Data aggregated from projections of analysts following the individual companies comprising the broad portfolio (i.e., the benchmark market index) as to their expectations of dividends and future stock prices (the so-called "bottom-up" approaches).

iii. Data on observations of risk premiums evidenced in the level of the S&P 500 index (or similar broad market index), corporate bond spreads (e.g., differences in yields on corporate bonds rated Baa and Aaa), or prices for credit default swaps.

iv. Surveys of expectations of respondents.

The goal of both the *ex post* and *ex ante* approaches is to estimate the *expected* ERP as of the valuation date.

Any estimate of the ERP must be made in relation to a risk-free security. That is, the ERP is measured as the difference between the expected return on a well-diversified portfolio of large company common stocks and the rate of return expected on a risk-free security. This relationship

[3.84] See, for example, the discussion in Eugene F. Fama and Kenneth R. French, "The Equity Premium," Journal of Finance (April 2002): 637–659.

ensures that the ERP used in estimating the cost of equity represents an expected ERP consistent with inflation expectations.

In valuing going-concern businesses and long-term investments made by businesses, valuation analysts generally use long-term U.S. government bonds as the risk-free security and use an estimate of ERP developed relative to long-term U.S. government bonds. This convention both represents a realistic, simplifying assumption and is consistent with the theory of the CAPM, provided there is no significant default risk associated with such long-term government securities.[3.85]

Most business investments have long durations and suffer from a reinvestment risk just as long-term government bonds do. As such, the use of long-term U.S. government bonds and an ERP estimated relative to such bonds more closely matches the investment horizon and risks confronting business managers in capital budgeting decisions, as well as in valuation issues.

Therefore, in the remainder of this chapter, we have translated all estimates of ERP to be expressed relative to 20-year U.S. government bonds rates.

Unconditional ERP

We will first examine the *unconditional ERP* (i.e., long-term average, sometimes called "equilibrium" ERP) using realized risk premium data (the *ex post* approach).[3.86] While academics and valuation analysts agree that ERP is a forward-looking concept, some valuation analysts, including taxing authorities and regulatory bodies, use historical data to estimate the ERP under the assumption that historical data are a valid proxy for current investor expectations. They like the appearance of accuracy, and we do emphasize the word *appearance*.

In the realized risk premium approach, the estimate of the ERP is the risk premium (realized return on stocks in excess of the risk-free rate) that investors have, on average, realized over some historical holding period. The underlying theory is that the past provides a reasonable indicator of how the market will behave in the future, and also that investors' expectations are influenced by the historical performance of the market.

A more direct justification for use of the realized risk premium approach is the contention that, for whatever reason, securities in the past have been priced in such a way as to earn the returns observed. By using an estimated cost of equity capital incorporating the average of realized risk premiums, the assumption is that one may to some extent replicate this level of pricing.

The long-term average of realized risk premiums is calculated from varying rates of returns on common stocks over fluctuating risk-free rates. They are generally reported annually. A common practice adds the same long-term average realized risk premium (an *ex post* estimate of the ERP)

[3.85] Eugene F. Fama, "Risk-Adjusted Discount Rates and Capital Budgeting Under Uncertainty," *Journal of Financial Economics*, 5(1) (1977): 3–24. This is true for both the original CAPM of Sharpe-Lintner-Mossin and the extension of the textbook CAPM, the intertemporal CAPM of Robert Merton.

[3.86] See, for example, Roger Ibbotson, "Equity Risk Premium", in Rethinking the Equity Risk Premium, ed. P. Brett Hammond, Jr., Martin L. Leibowitz, and Lawrence B. Siegel (The Research Foundation of CFA Institute, 2011): 18.

to the market (or "spot") interest rate of the risk-free security throughout the following year regardless of the level of the rate on that security as of the valuation date.

This common practice implicitly assumes that during upcoming periods the difference between the expected return on common stocks and U.S. government bonds is constant. Alternatively, this common practice implicitly assumes that any decrease or increase in the ERP as of the valuation date is short-term in nature and that the ERP is mean-reverting to the long-term average of realized risk premiums rather quickly.

Let us look at an example of the consequences of this common practice. If a valuation analyst were using the long-term average of realized risk premiums from, say 1926–2007 of 7.1% as the appropriate ERP estimate during 2008, that 7.1% ERP would have been added to the spot risk-free rate at any valuation date during 2008 regardless of the level of the risk-free rate during that year and regardless of any changes in risks in the economy.

For example, the yield on 20-year U.S. government bonds was 4.8% on October 31, 2008, resulting in a base cost of equity of 11.9% (4.8% + 7.1%). But due to the increase in economic and financial risks, as the Financial Crisis unfolded, the yield had fallen to 3.7% as of November 30, 2008, a result of significant flights to quality. Following this common practice, the 7.1% would have been added to this lower yield, resulting in a base cost of equity capital of 10.8% (3.7% + 7.1%), even though risk had clearly increased.[3.87]

In applying the historical (i.e., "realized") risk premium approach, an important consideration is the number of years of historical return data to include when calculating the average. One school of thought holds that the future is best estimated using a very long horizon of past returns, commonly going back to 1926. While the selection of 1926 as a starting point corresponds to the initial publishing of the forerunner to the current S&P 500 (the S&P Composite Index of 90 stocks), the choice of that date was otherwise arbitrary.

Another school of thought holds that the future is best measured by the (relatively) recent past. The average realized risk premium is sensitive to the period chosen for the average.

A summary of some of the issues that should likely be considered when selecting a time period over which to calculate a "historical" ERP estimate are as follows (this list is not exhaustive):

Reasons to focus on recent history:

- The recent past may be most relevant to an investor.
- Return patterns may change over time.

[3.87] Source of underlying figures: 2013 Ibbotson *SBBI® Valuation Yearbook* (Chicago: Morningstar, 2013): 57–61. The *SBBI® Valuation Yearbook* was discontinued in 2013.

- The longer period includes "unusual events" which may not be representation of today's economy.

- The relationship between stocks and bonds may have changed in more recent years compared to less recent years.

Reasons to focus on long-term history

- Long-term historical returns have shown surprising stability.

- Short-term observations may lead to illogical forecasts.

- Every period has dramatic historical events, and we do not know what major events lie ahead.

- Law of large numbers: More observations lead to a more accurate estimate.

- Differences in one's approach to estimating the ERP hinge even more on the measure of expected return on equity securities.

Realized Historical Stock and Bond Returns

The highest-quality data are available for periods beginning in 1926 from the Center of Research in Security Prices (CRSP) at the University of Chicago. Both this chapter and the Cost of Capital Navigator at dpcostofcapital.com contain summaries of returns on U.S. stocks and bonds derived from those data series. The reported returns include the effects from the reinvestment of dividends. Returns on common stocks have been assembled by various sources (and with various degrees of quality) for earlier periods. Reasonably good stock market return data are available back to 1872, and less reliable data are available back to the end of the eighteenth century. In the earliest periods, the market consisted almost entirely of bank stocks, and by the mid-nineteenth century, the market was dominated by railroad stocks. Data for government bond yield data have also been assembled for these periods.[3.88] Exhibit 3.18 presents realized average annual risk premiums for stocks assembled from various sources for alternative periods. Specifically, it displays the arithmetic average of realized risk premiums, the standard errors of estimate and the geometric average of realized risk premiums through the end of 2018. We measure the realized risk premium by comparing the stock market returns during the specified period to the *income return* on long-term U.S. government bonds (or total returns for the years prior to 1926).

While some may question the relevance of averages that include early periods for estimating today's ERP, what is striking is that the largest arithmetic average of one-year returns (of all the periods displayed in Exhibit 3.18) is the 93 years from 1926 to 2018.

[3.88] See Pratt and Grabowski, op.cit.: 143.

Exhibit 3.18: Realized Equity Risk Premiums: Stock Market Returns Minus U.S. Government Bonds Through 2018

Length (Yrs.)	Period Dates	Arithmetic Average (%)	Standard Deviation (%)	Standard Error (%)	Geometric Average (%)
20	1999–2018	3.05	17.97	4.02	1.45
30	1989–2018	6.30	17.35	3.17	4.59
40	1979–2018	6.37	16.00	2.53	4.81
50	1969–2018	4.66	16.83	2.38	3.08
93	1926–2018	6.91	19.85	2.06	4.82
119	1900–2018	6.64	19.54	1.79	4.60
147	1872–2018	5.90	18.61	1.54	4.08
221	1798–2018	5.12	17.88	1.20	3.47

Sources of underlying data: (i) Data compiled from R. Ibbotson and G. Brinson, *Global Investing* (New York: McGraw-Hill, 1993); W. Schwert, "Indexes of U.S. Stock Prices from 1802 to 1987", *Journal of Business* Vol. 63 (July 1990): 399–426; S. Homer and R. Sylla, *A History of Interest Rates*, 3rd ed. (Piscataway, NJ: Rutgers University Press, 1991); (ii) Morningstar, Inc. Used with permission. All rights reserved. (iii) CRSP U.S. Stock Database and CRSP U.S. Indices Database © Center for Research in Security Prices (CRSP®), The University of Chicago Booth School of Business. To learn more about CRSP, visit crsp.com. Calculations by Duff & Phelps, LLC.

Note that the data summarized in Exhibit 3.18 represent the arithmetic and geometric averages of realized risk premiums for one-year returns. That is, the dollars invested (including reinvested dividends) are reallocated to available investments annually, and the return is calculated for each year. The arithmetic average is the mean of the annual returns. The geometric average is the single compound return that equates the initial investment with the ending investment, assuming annual reallocation of investment dollars and reinvestment of dividends.

For example, assume the following series of stock prices, with a 0% dividend yield (i.e., no dividends):

Period	Stock Price ($)	Period Return (%)
1	10	n/a
2	20	100
3	10	-50

The arithmetic average of periodic returns equals (100% + –50%)/2 = 25%, and the geometric average equals [(1+ r1)(1+r2)]^(1/2) – 1 = [(1+1.0 x 1 – 0.5)]^(1/2) – 1 = 0%.

Realized risk premiums measured using the geometric (compound) averages are almost always less than those using the arithmetic average. The geometric mean is the lower boundary of the arithmetic mean, and the two are equal only in the unique situation that every observation is identical. The more variable the period returns however, the greater the difference between the arithmetic and geometric averages of those returns. This is simply the result of the mathematics of a series that has experienced deviations.

The choice between using the geometric and arithmetic average is a matter of disagreement among academics and valuation analysts. Using the arithmetic average for discounting net cash flow receives the most support in the literature.[3.89] Some authors recommend a geometric average.[3.90]

Why use the income return on long-term government bonds? The income return in each period represented the expected yield on the bonds at the time of the investment. Investors make a decision to invest in the stock market today by comparing the expected return from that particular investment to the rate of return today on a benchmark risk-free security (in this case, the long-term U.S. government bond). While investors did not know the stock market return when they invested at the beginning of each year, they did know the rate of interest promised on long-term U.S. government bonds when they were first issued. To try to match the expectations at the beginning of each year, we measure historical stock market returns on an expectation that history will repeat itself over the expected return on bonds in each year.

The realized risk premiums vary year to year, and the estimate of the *true* ERP resulting from this sampling is subject to some degree of error. We display the standard errors of estimate in Exhibit 3.18. The standard error of an estimate allows you to measure the likely accuracy of using the realized risk premium as the estimate of the *true* ERP, assuming that the observations are drawn from a distribution of returns that is still relevant. This statistic indicates the estimated range within which the *true* ERP falls (e.g., assuming normality, the true ERP can be expected to fall within two standard errors with a 95% level of confidence).

In choosing the years one includes in the estimate, the valuation analyst is looking for a period in which the realized returns best represent what might be expected in future periods. One might consider eliminating from the sample periods influenced by abnormal circumstances, or one might instead consider a sample period with risk characteristics more comparable to the risk characteristics confronting investors today.

World War II Interest Rate Bias

Some observers have suggested that the period including the 1940s and the immediate post-World War II boom years may have exhibited unusually high average realized return premiums due to the Fed's intervention in the bond markets to control interest rates.[3.91]

[3.89] See, for example, Zvi Bodie, Alex Kane, and Alan J. Marcus, *Investments* (Chicago: Irwin Professional Publishing, 1989): 720–723; Mark Kritzman, "What Practitioners Need to Know about Future Value, " *Financial Analysts Journal* (May/June 1994): 12–15; Paul Kaplan, "Why the Expected Rate of Return Is an Arithmetic Mean," *Business Valuation Review* (September 1995); Roger Ibbotson, "Equity Risk Premium", in *Rethinking the Equity Risk Premium*, ed. P. Brett Hammond, Jr., Martin L. Leibowitz, and Lawrence B. Siegel (The Research Foundation of CFA Institute, 2011): 20; 2012 Ibbotson Associates/Morningstar *SBBI® Valuation Yearbook*: 56–57; Elroy Dimson, Paul Marsh and Mike Staunton, *Credit Suisse Global Investment Returns Sourcebook* 2019 (London: Credit Suisse/London Business School, 2019).

[3.90] See, for example, Aswath Damodaran, *Investment Valuation: Tools and Techniques for Determining the Value of Any Asset*, 3rd ed. (Hoboken, NJ: John Wiley & Sons, 2012): 162–163; Aswath Damodaran, "Equity Risk Premiums (ERP): Determinants, Estimation and Implications – The 2018 Edition," (March 2018): 32–33, available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3140837.

[3.91] See, for example, Aswath Damodaran, *Investment Valuation: Tools and Techniques for Determining the Value of Any Asset*, 3rd ed. (Hoboken, NJ: John Wiley & Sons, 2012): 162–163; Aswath Damodaran, "Equity Risk Premiums (ERP): Determinants, Estimation and Implications – The 2018 Edition," (March 2018): 32–33, available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3140837.

We consider the years 1942 through 1951 particularly problematic as they reflected a period of government-imposed stability in U.S. government bond yields. During World War II, the U.S. Treasury department (the "Treasury") decreed that interest rates had to be kept at artificially low levels in order to reduce government financing costs. This led to the Fed's April 1942 public commitment to maintain interest rates at prescribed levels on U.S. government debt, both long-term and short-term.[3.92]

With regard to short-term interest rates, the Fed agreed to make a market in 3-month T-bills at a yield of 3/8 of a percent (0.375%). With regards to longer-term securities, the Fed agreed to support interest rate ceilings; for example, it agreed to support 25-year U.S. government bond prices at a level consistent with a 2.5% interest rate ceiling. For perspective, the current policy being implemented by the central bank of Japan, by targeting 0.0% (zero) on 10-year Japanese government bonds, is a variant of what the Fed did back in the 1940s.

After World War II, the Fed continued to maintain an interest rate ceiling due to the Treasury's pressure and, to a lesser extent, a fear of returning to the high unemployment levels of the Great Depression. The Treasury and the Fed ended the pegging of interest rates on T-bills in July 1947. But interest rate controls on long-term rates continued until postwar inflationary pressures caused the Treasury and the Fed to reach an accord announced March 4, 1951, freeing the Fed of its obligation of pegging interest rates.[3.93] Including this period when calculating realized returns is analogous to valuing airline stocks today by looking at prices of airline stocks when domestic airline fares were regulated.

To better understand the impact of the interest rate controls on the ERP, we examined the annual arithmetic average of realized risk premiums for the period 1926–2018 (including all years), and the annual arithmetic average of realized risk premiums for the period 1926–2018 *excluding 1942 through 1951*. Exhibit 3.19 displays these results.

Exhibit 3.19: Realized Risk Premiums Including and Excluding the Years 1942–1951

Period Dates	Realized Risk Premiums (arithmetic average) (%)
1926–2018	6.91
1926–2018 (excluding 1942–1951)	5.86

Source of underlying data: Morningstar, Inc. Used with permission. All rights reserved. Calculations by Duff & Phelps.

Eliminating the years 1942 through 1951 from the sample reduced the realized risk premium as calculated over 1926–2018 from 6.91% to 5.86%. One can interpret the realized risk premium data reported herein as being biased high by as much as 1.06% (6.91% – 5.86%; difference due to

[3.92] Mark Toma, "Interest Rate Controls: The United States in the 1940's," The Journal of Economic History 52(3) (September 1992): 633–634.

[3.93] Jerry W. Markham, A Financial History of the United States, vol. 1 (Armonk, NY: M.E. Sharpe, 2002): 299–300.

rounding). We will call this the "WWII Interest Rate Bias." We use 1.06% as the adjustment below to indicate the extent of the possible bias created by this period in the indicated ERP estimates we display.

We are not questioning the accuracy of the realized risk premiums reported using the former Morningstar SBBI® data. Rather, we believe that if one were using the realized return data as a basis for forecasting ERP, demonstrated biases should be removed where possible. Removing the data from 1942–1951 from the sample allows the valuation analyst to make the data more representative of what might be expected in future years. We believe that valuation analysts should at least consider the WWII Interest Rate Bias when estimating ERP using realized risk premium data.[3.94]

"Market" rates subject to control are really not market rates reflective of real interest rates plus the market's expectations of inflation. This was true during the 1942–1951 period and is true as we are writing this book due to the actions of the Fed through quantitative easing measures.

Comparing Investor Expectations to Realized Risk Premiums

Much has been written comparing the realized risk premiums as reported in sources – such as past editions of the *Ibbotson® SBBI® Valuation Yearbooks* – and the ERP that must have been expected by investors, given the underlying economics of publicly traded companies (e.g., expected growth in earnings or expected growth in dividends) and the underlying indicators for the economy (e.g., expected growth in gross domestic product or GDP). Such studies conclude that investors could not have expected as large an ERP as the risk premiums actually realized historically.[3.95]

Ibbotson and Chen report on a study in which they estimated forward-looking long-term sustainable equity returns and expected ERPs since 1926. They first analyzed realized equity returns by decomposing returns into factors including inflation, earnings, dividends, price-to-earnings ratios, dividend payout ratios, book values, returns on equity, and GDP per capita (the fundamental building blocks of equity returns being "supplied" by companies).

They forecasted the ERP through supply-side models built from historical data by removing the price-to-earnings ratio inflation (a top-down approach for estimating the market's re-pricing due to the underlying economic changes in aggregate). Those authors determined that the long-term ERP that could have been expected, given the underlying economics, was less than the realized premium.[3.96]

[3.94] Some disagree with our conclusion. See for example, Kevin Piccolo, "The Dangers of Normalization: An Interest-Rate Perspective," The Value Examiner (March/April 2012): 23–32.

[3.95] Several of those studies are summarized in Pratt and Grabowski, op.cit., Chapter 8A, "Deriving ERP Estimates": 147–153.

[3.96] Roger G. Ibbotson and Peng Chen, "Long-Run Stock Market Returns: Participating in the Real Economy" *Financial Analysts Journal* (January February 2003): 88–98; see also Charles P. Jones and Jack W. Wilson, "Using the Supply Side Approach to Understand and Estimate Stock Returns," Working paper, June 6, 2006.

We updated the "supply side" ERP over the 1926–2018 for the 2019 data year in the Cost of Capital Navigator. The supply-side ERP estimate is 4.19% (on a geometric basis), and 6.14% (on an arithmetic basis), as shown in Exhibit 3.20. In comparison, the realized (historical) 1926–2018 ERP was 4.82% (on a geometric basis), and 6.91% (on an arithmetic basis). [3.97]

We are using the methodology consistent with that used in the discontinued *SBBI® Valuation Yearbook*. We examined the compound annual growth in price-to-earnings ratios from 1926 to the current year where the current year's price-to-earnings ratio is calculated using a three-year average of earnings. Using the three-year average allows the adjustment to smooth out the volatility of extraordinary events and allows earnings to better reflect a normalized trend.

In order to keep the measurement of the three-year average earnings consistent with the price of the S&P 500 Index at the time that the supply side adjustment is calculated (e.g., the price of the S&P 500 at December 31, 2018, for the supply-side long-term ERP estimate as of the end of 2018), we used the three-year average based on the prior-year's earnings, the current year's earnings estimated at year-end, and the forecast earnings in the following year. [3.98]

For example, the adjustment is based on the S&P 500 Index price at December 31, 2018, divided by the average of the earnings for the S&P 500 companies in 2017, which are known, 2018, which are estimated, and 2019, which are forecasted.[3.99] Obviously since the actual 2018 earnings will not be known until 2019, and the forecast 2019 earnings will not be known until 2020, the adjustment as of the end of 2018 will change in the Cost of Capital Navigator (and in future updates to this chapter) as of the end of 2019 and 2020.[3.100] We then adjusted the realized risk premiums from 1926 to the current year by removing this observed growth in price-to-earnings ratios, which has occurred primarily in the past 30 years.

3.97 The long-term 1926–present "historical" and "supply-side" ERPs were published on the "back page" (i.e., "Key Variables in Estimating the Cost of Capital") of the Ibbotson Associates/Morningstar *SBBI® Valuation Yearbook* from 1999–2013 and 2004–2013, respectively. The long-term 1926–present historical and supply-side ERPs, calculated using the same data and methodology as were used in the former *SBBI® Valuation Yearbook*, were found in Appendix 3, "CRSP Deciles Size Premia Study: Key Variables" in the 2014–2018 editions of the *Valuation Handbook – U.S. Guide to Cost of Capital*. This data is now only available online through a subscription to the Duff & Phelps' Cost of Capital Navigator. For more information, visit: dpcostofcapital.com.

3.98 The choice in using a three-year average is an exercise in judgement. See Magdalena Mroczek, "Unraveling the Supply-Side Equity Risk Premium," *The Value Examiner* (January/February 2012): 19–24.

3.99 The estimated top-down earnings estimate for the S&P 500 for the calendar year (in the analysis herein, 2019) following the most recently completed calendar year (in the analyses herein, 2018) used in the supply side ERP estimate is provided by Standard & Poor's at http://us.spindices.com/indices/equity/sp-500.

3.100 The geometric average supply-side ERP of 4.19% (see Exhibit 3.20) was converted into an (estimated) arithmetic average using the standard deviation of the annual returns of the S&P 500 total returns index, as measured over the period 1926–2018 (19.8%), which resulted in a supply-side arithmetic average ERP of 6.14%. The extra return attributable to the price-to-earnings multiple expansion was 0.6% per annum, when calculating the supply side ERP based on the three-year averaging convention. The extra return due to the price-to-earnings multiple expansion through 2018 was 0.61% per annum using 1-year periods.

William Goetzmann and Roger Ibbotson, commenting on the supply side approach of estimating expected risk premiums, note:[3.101]

> *"These forecasts tend to give somewhat lower forecasts than historical risk premiums, primarily because part of the total returns of the stock market have come from price-earnings ratio expansion. This expansion is not predicted to continue indefinitely and should logically be removed from the expected risk premium."*

Peng Chen estimated the ERP as of early 2011 relying on the supply side model exclusively.[3.102] To the authors of this book, this certainly indicates his preference of the supply side estimate to the straight historical average estimate.

Since this adjustment for the growth in price-to-earnings ratios reflects primarily changes observed during the past 30 years and the supply side analysis (as we have implemented it) makes no other adjustments to the realized returns, one might interpret that a forward estimate of the long-term ERP derived from data through December 31, 2018 should be 6.14% (supply-side model on an arithmetic average basis) minus the 1.06% WWII Interest Rate Bias discussed earlier, or 5.08% (differences, due to rounding) for one-year holding period returns.

Unconditional ERP Estimates

The following summarizes the long-term unconditional ERP estimates as of 2018:

Exhibit 3.20: Long-term Realized Risk Premiums Measured Relative to Long-term U.S. Government Bonds

Adjusted Realized Risk Premium	Period	Arithmetic Average (%)	Geometric Average (%)
Long-term "Historical" ERP	1926–2018	6.91	4.82
Long-term "Supply-side" ERP	1926–2018	6.14	4.19
"Supply-side" minus WWII Interest Rate Bias ERP	1926–2018	5.08	n/a

Source of underlying data: Morningstar, Inc. Used with permission. All rights reserved. Calculations by Duff & Phelps.

The analyses summarized in Exhibit 3.20 are estimates of ERP measured relative to U.S. government bonds and that, with the exception of periods of governmental intervention in U.S. government long-term bonds (i.e., the period resulting in the WWII Interest Rate Bias (1942–1951) as discussed previously), the returns on bonds generally reflected a market based pricing of yields, not impacted by actions by the Fed to suppress yields on long-term U.S. government bonds.

[3.101] William N. Goetzmann and Roger G. Ibbotson, "History and the Equity Risk Premium," Chapter 12 in *Handbook of the Equity Risk Premium*, ed. Rajnish Mehra (Amsterdam: Elsevier, 2008): 522–523.

[3.102] Peng Chen, "Will Bonds Outperform Stocks over the Long Run? Not Likely," in *Rethinking the Equity Risk Premium*, ed. P. Brett Hammond, Jr., Martin L. Leibowitz, and Lawrence B. Siegel (The Research Foundation of CFA Institute, 2011): 117–129.

One could argue, for example, that if a "historical" ERP were adjusted for periods in which non-market forces artificially depressed U.S. government bond yields, then matching the Duff & Phelps normalized risk-free rate with this "adjusted" historical ERP might be appropriate. We agree, but with *significant* qualifications. For example, in Exhibit 3.19 and Exhibit 3.20 we report what the long-term "historical" ERP and the long-term "supply-side" ERP would be if the WWII interest rate bias were subtracted from each. The differences are significant: these analyses suggest (for example) that the long-term historical ERP as measured over the 1926–2018 period is overstated by up to 1.06%. While this analysis is compelling, and adjusting the "historical" ERP in this fashion likely does make the concept of matching the Duff & Phelps normalized risk-free rate with an "adjusted" historical ERP more correct, the reality is that this approach is not as internally consistent as compared to that of matching the Duff & Phelps normalized risk-free rate with the Duff & Phelps recommended ERP.

We express the unconditional ERP in terms of an arithmetic average equivalent, which is appropriate for estimating single-period discount rates for discounting net cash flows to present value (e.g., the build-up method, the CAPM, etc.)

Conditional ERP

Prior to September 2008 and the Financial Crisis, it was quite common for analysts to be content to make an ERP estimate once each year. Even if the ERP changed month to month, the magnitude of the change was not very great. But beginning in September 2008, the stock market and the economy started to tumble into crisis and valuation analysts began to question the stability of their ERP estimates: (i) should one be adjusting their ERP more often than annually and (ii) if the answer to this question was "yes," then how should one estimate the ERP? Clearly, simply using a long-term average of realized risk premiums was not going to work during the Financial Crisis. This became very obvious at the end of December 2008.

If one simply added an estimate of the ERP taken from sources commonly used before the Financial Crisis to the spot yield on 20-year U.S. government bonds at month-end December 2008, one would have arrived at an estimate of the cost of equity capital that was too low.

For example, as illustrated in Exhibit 3.16, at December 2007 the yield on 20-year U.S. government bonds equaled 4.5%, and the realized risk premium reported based on the average realized risk premiums for 1926–2007 was 7.1%. But at December 2008, the yield on 20-year U.S. government bonds was 3.0%, and the realized risk premium reported based on the average realized risk premiums for 1926–2008 was 6.5%. So just at the time that the risk in the economy *increased* to arguably the highest point, the base cost of equity capital using realized risk premiums *decreased* from 11.6% (4.5% plus 7.1%) to 9.5% (3.0% plus 6.5%).[3.103]

[3.103] While some commentators proposed that analysts adjust their cost of capital estimates as of December 2008 by using a company specific risk premium, the authors of this book believe that this mischaracterizes the observed risks in the markets. Rather, risk-free interest rates declined dramatically due to primarily a flight-to-quality and the expected ERP increased. Neither of these events were company-specific risk issues. However, if the inclusion of increased market risk were done properly, the result should be broadly the same.

Research has shown that ERP varies through business cycles.[3.104] In trying to dispel the myth that the ERP should be static across time and across assets, one academic uses precisely the Financial Crisis as the counterargument that the ERP is indeed time-varying:[3.105]

> *"Why should the broad stock market command the same risk premium when it is gripped by fear of the apocalypse in the financial services community (as in early 2009) as when optimism is being fueled by a booming economy and a startling surge in technological innovation (as in early 2000)? The year 2009 felt riskier than 2000. So, should stocks have broadly commanded a higher risk premium (and, therefore, a lower price) in 2009 than in 2000? Intuitively, the ERP should obviously vary both across time and across assets."*

We use the term *conditional ERP* to mean the ERP that reflects current market conditions. Those market conditions reflect both the risk of investments as viewed through the collective eyes of the marginal investors (those investors moving money into and out of investments at a particular date; i.e., those investors setting prices) and the collective risk aversion as viewed through those same marginal investors. For example, the ERP should be greater when uncertainty is greater and smaller when uncertainty is smaller.[3.106]

Besides being time-varying, the ERP is countercyclical.[3.107] When the economy is near or in recession (as reflected in relatively low returns on stocks and greater economic uncertainty), the *conditional* ERP is likely at the higher end of the range (e.g., at December 31, 2008). When the economy improves (with expectations of improvements reflected in recent increasing stock returns), the *conditional* ERP likely moves toward the midpoint of the range. When the economy is near its peak (and reflected in relatively high stock returns and increased economic certainty), the *conditional* ERP is likely at the lower end of the range.

Duff & Phelps Recommended U.S. ERP

There is no single universally accepted methodology for estimating the ERP; consequently, there is wide diversity in practice among academics and financial advisors regarding ERP estimates. In estimating the conditional ERP, valuation analysts cannot simply use the long-term historical ERP, whether as reported or adjusted as we discussed above. A better alternative would be to examine approaches that are sensitive to the current economic conditions.

Duff & Phelps employs a multi-faceted analysis to estimate the conditional ERP that takes into account a broad range of economic information and multiple ERP estimation methodologies to arrive at its recommendation.[3.108]

3.104 See for example, Antti Ilmanen, "Time Variation in the Equity Risk Premium," in *Rethinking the Equity Risk Premium*, ed. P. Brett Hammond, Jr., Martin L. Leibowitz, and Lawrence B. Siegel (The Research Foundation of CFA Institute, 2011).

3.105 Robert D. Arnott, "Equity Risk Premium Myths," in *Rethinking the Equity Risk Premium*, ed. P. Brett Hammond, Jr., Martin L. Leibowitz, and Lawrence B. Siegel (The Research Foundation of CFA Institute, 2011): 79.

3.106 See Martin Lettau, S. C. Ludvigson, and J. A. Wachter, "The Declining Equity Risk Premium: What Role Does Macroeconomic Risk Play?," *Review of Financial Studies* 21 (2008): 1675–1687. The authors linked changes in the ERP to changes in the volatility of economic variables such as employment, consumption, and growth in GDP.

3.107 Siegel, Laurence B., "The Equity Risk Premium: A Contextual Literature Review", *CFA Institute Research Foundation Volume 12, Issue 1*, November 2017, ISBN: 978-1-944960-31-5: 9.

3.108 For a downloadable table (in PDF format) of the Duff & Phelps recommended ERP over time (2007 through present), go to www.DuffandPhelps.com/CostofCapital

First, a reasonable range of normal or unconditional ERP is established.

Second, based on current economic conditions, Duff & Phelps estimates where in the range the true ERP likely lies (top, bottom, or middle) by examining the current state of the economy (both by examining economic indicators and forecasts, as well as by analyzing the level and trends of stock market indices as forward indicators), in conjunction with the implied equity volatility and corporate spreads as indicators of perceived risk.

In Exhibit 3.21, we list the primary factors considered when arriving at the Duff & Phelps recommended U.S. ERP. We document the evolution of these factors from December 31, 2017 – the last time we confirmed our recommendation – through December 31, 2018, along with the corresponding relative impact on ERP indications.

Exhibit 3.21: Factors Considered in the U.S. ERP Recommendation: Relative Changes from December 31, 2017 to December 31, 2018

Factor	Change	Effect on ERP
U.S. Equity Markets	↓	↑
Implied Equity Volatility	↑	↑
Corporate Debt Spreads	↑	↑
EPU and Equity Uncertainty	↑	↑
Historical GDP Growth and Forecasts	↑	↓
Unemployment Environment	↔	↔
Consumer Confidence	↔	↔
Business Confidence	↓	↑
Sovereign Credit Ratings	↔	↔
Default Spread Model	↑	↑
Damodaran Implied ERP Model	↑	↑

Analysis of Relative Changes from December 31, 2017 to December 31, 2018

Based on market conditions as of December 31, 2018, we recommended an increase in the U.S. ERP from 5.0% to 5.5% when developing discount rates as of December 31, 2018 and thereafter, until there is evidence indicating equity risk in financial markets has materially changed and new guidance is issued.

Duff & Phelps last changed its U.S. ERP recommendation on September 5, 2017.[3.109] On that date, our recommendation was decreased to 5.0% (from 5.5%) in response to evidence in early and mid-2017 that suggested a subdued level of risk in financial markets. Back then, strong earnings growth, still-accommodative monetary policies, and benign global macroeconomic trends buoyed U.S. stocks. Corporate earnings had surpassed expectations, fueling hopes for even higher dividend payouts and stock buybacks. Investors' perception of negligible levels of risk was manifested through record-low levels of equity volatility and a sharp narrowing of corporate credit spreads.

The optimism in equity markets persisted into late 2017 and early 2018, after the passage into law of the largest U.S. corporate tax reform in over 30 years.[3.110] The Tax Cuts and Jobs Act, enacted on December 22, 2017, cut both personal income tax rates (temporarily through 2025) and the statutory corporate tax rate from 35% to 21% (permanently), among many other provisions. While not all industries were anticipated to be net beneficiaries from the U.S. tax reform, investors appeared to be expecting (on average) a substantial increase in after-tax corporate earnings, which spurred further stock market records. The combination of these upbeat economic and financial market conditions led Duff & Phelps to reaffirm its U.S. ERP recommendation of 5.0% as of December 31, 2017, to be used in conjunction with a normalized risk-free rate of 3.5%.[3.111]

February 2018 saw a spike in volatility, partly fed by concerns that a rise in inflation could lead to an acceleration in interest rate hikes. However, this proved to be temporary, with U.S. equity markets quickly bouncing back and reaching new record highs in September 2018.

From October through December 2018, the picture that emerged was very different: U.S. stock prices suffered significant losses, with an accompanying surge in equity volatility and a widening of corporate credit spreads. Broad U.S. stock market indices ended 2018 with negative total returns. This was the worst negative performance since 2008 at the height of the global Financial Crisis. The deterioration in economic indicators and financial market conditions at the end of 2018 led us to revisit our U.S. ERP recommendation.

Current Economic Conditions[3.112]

Gross Domestic Product

Macroeconomic conditions provide the foundation for financial market performance, with economic growth influencing the level of interest rates, inflation, corporate earnings, and other factors that impact financial asset returns.

3.109 Refer to the Duff & Phelps Client Alert issued on October 30, 2017, which was titled "Duff & Phelps' U.S. Equity Risk Premium Recommendation Decreased from 5.5% to 5.0%, Effective September 5, 2017". To obtain a free copy of this Client Alert and prior ones documenting the Duff & Phelps' U.S. ERP recommendation over time, visit: www.DuffandPhelps.com/CostofCapital.

3.110 See, for example, Paletta, Damian and Stein, Jeff, "Sweeping tax overhaul clears Congress" The Washington Post, December 20, 2017. This article is accessible here: https://www.washingtonpost.com/business/economy/gop-tax-bill-passes-congress-as-trump-prepares-to-sign-it-into-law/2017/12/20/0ba2fd98-e597-11e7-9ec2-518810e7d44d_story.html?utm_term=.9266de939dfb

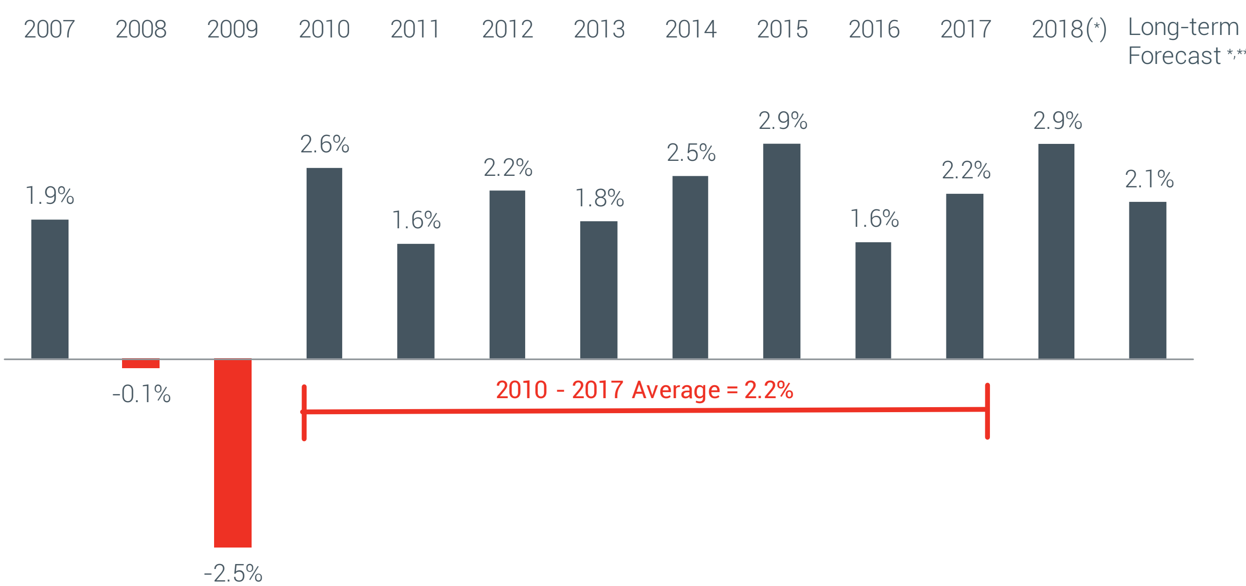
3.111 For a more detailed discussion of this decision, refer to Chapter 3 of the Duff & Phelps *2018 Valuation Handbook – U.S. Guide to Cost of Capital*, available exclusively online through the Duff & Phelps Cost of Capital Navigator at dpcostofcapital.com.

3.112 The discussion in this section was based on the review of data for periods ended on or around December 31, 2017, with selected data updated through the end of January 2018. However, general information available through the time of writing (April 15, 2018) was also considered as corroborating evidence.

Global economic prospects improved markedly in late 2016 and during 2017. According to the International Monetary Fund (IMF), 2017 saw the broadest synchronized global growth upsurge since 2010.[3.113] However, the geographic contribution to global growth was notably different in 2018, with the U.S. leading the pack, while other regions started seeing varying degrees of economic slowdown.

Almost 10 years have elapsed since the U.S. economy began its recovery from the Financial Crisis. The 2008–2009 U.S. recession was declared officially over in June 2009 and was of greater duration than those of 1973–1975 and 1981–1982. The current business cycle expansion is now the second longest in U.S. history.[3.114] However, the recent recovery has fallen short of the rebound observed in other post-World War II recessions. Real GDP growth in the year following the recessions of 1957–58, 1973–75, and 1981–82 was on average 5.6%. In contrast, real GDP expanded by 2.6% during 2010 and by an average of 2.2% over the 2010–2017 period. Most economists believe that the long-term U.S. real GDP growth potential is now below the long-term historical trend of around 3.0%. (see Exhibit 3.22).[3.115]

Exhibit 3.22: U.S. Real Gross Domestic Product (GDP) Growth: 2007–2018



Source of underlying data: Historical data: U.S. Bureau of Economic Analysis.
*Forecast data based on average from the following: The Livingston Survey, December 21, 2018; Survey of Professional Forecasters, Fourth Quarter 2018, November 13, 2018; Blue Chip Financial Forecasts, January 1, 2019; Blue Chip Financial Forecasts, January 1, 2019; Blue Chip Economic Indicators, October 10, 2018; Blue Chip Economic Indicators, December 10, 2018; Consensus Forecasts USA, December 2018; Bloomberg's Contributor Composite estimates, dated January 14, 2019.
** Long-term is primarily based on forecasts for the next 10 years.

3.113 "World Economic Outlook Update, January 2018 – Brighter Prospects, Optimistic Markets, Challenges Ahead", International Monetary Fund. Accessible here: https://www.imf.org/en/Publications/WEO/Issues/2018/01/11/world-economic-outlook-update-january-2018.

3.114 "U.S. Business Cycle Expansions and Contractions", National Bureau of Economic Research. https://www.nber.org/cycles.html

3.115 Source of historical real GDP growth data: U.S. Bureau of Economic Analysis, http://www.bea.gov.

However, a spending boost fueled by individual and corporate tax cuts introduced in late 2017 by the Tax Cuts and Jobs Act, combined with a strong employment situation, restored optimism for 2018. As illustrated in Exhibit 3.22, U.S. real GDP is forecasted to have grown by a robust 2.9% in 2018, well above its projected long-term average of 2.1%. Nevertheless, consensus among economists and professional forecasters point to a deceleration in economic activity in 2019 and beyond, as the effect of the fiscal stimulus gradually fades. Moreover, a projected slowdown in global economic growth has the potential for negative spillover effects into the U.S. economy, a risk that worried investors in the fourth quarter of 2018.

Labor Market

The labor market had its best year in decades in 2018. The annual unemployment rate averaged 3.9%, the lowest level since 1969. During the second half of the year, the monthly unemployment rate oscillated between 3.7% and 3.9%, the former being the lowest monthly rate since 1969 while the latter had been last observed back in 2000 during the Dot-com bubble.[3.116]

Economic theory would suggest that a tight labor market and rapid economic growth would create upward pressure on wages and prices, ultimately leading to an increase in inflation. This relationship is often dubbed the "Phillips curve".[3.117] However, a significant increase in inflation has yet to be observed in the current U.S. economic recovery, which may imply that either the theory underlying the Phillips curve no longer holds, or that there is still some slack (i.e., unused capacity) in the U.S. economy not fully captured by the traditional unemployment rate measure (among other possible explanations).[3.118, 3.119]

Inflation

The Fed's preferred measures of inflation – the trailing 12-month personal consumption expenditures price index (PCE) and the core PCE (i.e., excluding food and energy prices) – have remained below the U.S. central bank's target rate of 2.0% until relatively recently.[3.120]

3.116 Source of historical monthly and annual unemployment rates: U.S. Bureau of Labor Statistics, Civilian Unemployment Rate, https://www.bls.gov/.

3.117 The inverse relationship between inflation and unemployment is captured by the so-called "Phillips curve," named after economist A. W. Phillips for his work in the 1950s. For a more detailed discussion on variations and extensions of the Phillips curve, as well as how well it captures the relationship between employment and inflation, see for example Peach, Richard, Robert Rich, and Anna Cororaton (2011), "How Does Slack Influence Inflation?", *Current Issues in Economics and Finance*, Volume 17, Number 3, Federal Reserve Bank of New York. Available here: https://www.newyorkfed.org/medialibrary/media/research/current_issues/ci17-3.pdf.

3.118 St. Louis Federal Reserve bank president James Bullard argued in a presentation in the 2018 ECB Forum on Central Banking that the empirical relationship between unemployment and inflation disappeared. A copy of the presentation can be accessed here: https://www.stlouisfed.org/~/media/files/pdfs/bullard/remarks/2019/bullard_usmpf_22_february_2019.pdf?la=en.

3.119 The official unemployment rate, labeled as U-3 by the U.S. Bureau of Labor Statistics, is comprised of total unemployed workers as a percentage of the civilian labor force. U-6, a broader definition of the unemployment rate is computed using the following ratio: [Total unemployed(U-3) + All persons marginally attached to the labor force + Total employed part time for economic reasons]/ [Civilian labor force + All persons marginally attached to the labor force]. The U-6 measure was 7.6% in December 31, 2018. Source: https://www.bls.gov/.

3.120 Personal Consumption Expenditure Price Index (PCE) tracks more inclusive basket of goods and services compared to the Consumer Price Index (CPI). The CPI covers only out-of-pocket expenditures, where PCE includes expenditures not paid for directly by consumers, for example, medical care provided by employers. For more details on the difference between the two inflation measures see: https://www.clevelandfed.org/newsroom-and-events/publications/economic-trends/2014-economic-trends/et-20140417-pce-and-cpi-inflation-whats-the-difference.aspx.

The first half of 2018 saw readings consistently near or exceeding 2.0%, which together with a strong labor market and robust real GDP growth, provided the Fed some comfort to continue to raise the target range of its benchmark short-term interest rate (the federal funds rate). However, by December 2018, the trailing 12-month PCE dipped again to 1.8%, while the core PCE ended the year at 2.0%. January 2019 saw further declines in both of these inflation measures.[3.121] The trailing headline Consumer Price Index (CPI) and the core CPI (i.e., excluding food and energy) ended the year 2018 on a similar note. The headline CPI rose by 1.9% and the core CPI rose by 2.2% in 2018, on a trailing 12-month basis.[3.122]

Global Economic Outlook

At the beginning of 2018, the expectations were for global economic growth to continue at similar levels to 2017. However, during the year, the rise of trade tensions – particularly between the U.S. and China – and the softening of the economic situation in China and Europe began to create uncertainty among companies and investors. Throughout the year, economic forecasts were progressively downgraded by major institutions and market participants.

For instance, in the March and May 2018 updates to its economic outlook the Organization for Economic Co-operation and Development (OECD) reported that global economic expansion was strengthening.[3.123, 3.124] By September, however, the OECD warned that global growth was hitting a plateau, and that risks from trade restrictions and tighter financial conditions had started to materialize in some countries.[3.125] By November, the OECD concluded that, while strong, global GDP growth had already peaked, and that the 2019 growth forecasts had been lowered for most of the world's major economies.[3.126] Based on data observed in late 2018, the OECD became even more negative about the economic outlook, having revised its growth projections downward for most of the G-20 economies.[3.127, 3.128]

3.121 U.S. Bureau of Economic Analysis, Personal Consumption Expenditures Price Index. Data can be found in the "Personal Income and Outlays" release, Table 11. Price Indexes for Personal Consumption Expenditures: Percent Change From Month One Year Ago. For the latest release and access to previously published monthly estimates, visit: https://www.bea.gov/data/personal-consumption-expenditures-price-index.

3.122 U.S. Bureau of Labor Statistics, CPI-All Urban Consumers (Current Series), available at: http://www.bea.gov. CPI inflation is based on the "All Items in U.S. City Average, All Urban Consumers" series, whereas core CPI inflation is based on the "All Items less Food and Energy in U.S. City Average, All Urban Consumers" series.

3.123 Pereira, Álvaro, "Getting stronger, but tensions are rising," oecdecoscope, March 13, 2018. Accessed here: https://oecdecoscope.blog/2018/03/13/getting-stronger-but-tensions-are-rising/.

3.124 Pereira, Álvaro, "Stronger Growth but Risks loom large," oecdecoscope, May 30, 2018. Accessed here: https://oecdecoscope.blog/2018/05/30/stronger-growth-but-risks-loom-large/.

3.125 Boone, Laurence, "High uncertainty is weighing on global growth," oecdecoscope, September 20, 2018. Accessed here: https://oecdecoscope.blog/2018/09/20/high-uncertainty-is-weighing-on-global-growth/.

3.126 Boone, Laurence, "Editorial: Growth has peaked: Challenges in engineering a soft landing," OECD Economic Outlook November 2018. Accessed here: http://www.oecd.org/economy/outlook/growth-has-peaked-challenges-in-engineering-a-soft-landing.htm.

3.127 Boone, Laurence, "Global growth is weakening: coordinating on fiscal and structural policies can revive euro area growth," oecdecoscope, March 6, 2019. Accessed here: https://oecdecoscope.blog/2019/03/06/global-growth-is-weakening-coordinating-on-fiscal-and-structural-policies-can-revive-euro-area-growth/.

3.128 The G-20 is comprised of 19 countries plus the European Union (EU). The 19 countries are Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, United Kingdom, and United States. For more details visit: https://g20.org/en/.

Similarly, the IMF began 2018 on an optimistic note, but as the year progressed its global economic projections became bleaker. In April 2018, the IMF was still quite upbeat, citing supportive financial conditions as the reason to upgrade its 2018 and 2019 global growth rates to a level even higher than 2017. Additionally, the IMF stated that growth that strong and broad-based had not been seen since 2010, when the initial rebound from the Financial Crisis was observed.[3.129]

In July, the IMF maintained its 2018 and 2019 projected global growth rates but warned that the economic expansion was becoming less even, and that risks to the outlook were rising.[3.130] The IMF conjectured that the rate of expansion had peaked in some major economies and growth had become less synchronized. In October 2018, shortly after the tenth anniversary of the Lehman Brothers collapse, the IMF portrayed a more unbalanced outlook.[3.131] While growth in the U.S. remained remarkably robust, near-term prospects for the Eurozone, the United Kingdom, and China had deteriorated. Threats of retaliatory trade policies by the U.S., possible failure of Brexit negotiations, and tightening financial conditions for emerging markets, as these economies tried to adjust to the Fed's progressive rate hikes, were cited as factors adding to the uncertainty.

Examining confirmatory evidences published after the effective date for the new Duff & Phelps' recommended U.S. ERP, IMF reports released in early 2019 confirmed a worsening trend in global economic conditions.[3.132]

Current Financial Market Conditions

Duff & Phelps increased its U.S. ERP recommendation on December 31, 2018 (from 5.0% to 5.5%). This change in recommendation reflects the perceived increase in aggregate risks in U.S. markets.

U.S. Equity Markets

2018 marked the tenth anniversary of the Financial Crisis and the longest bull market in history. By the end of the third quarter, equity markets registered their highest record yet. The NASDAQ Composite Index (NASDAQ) Index set an all-time high of 8,109.69 on August 29, 2018, the S&P 500 reached a record on September 20 by closing at 2,930.75, and the Dow Jones Industrial Average (DJIA) closed at its highest level ever on October 3 at 26,828.39. With the beginning of the fourth quarter of 2018, the trend started to falter, and markets performance started to turn negative. The month of October saw S&P 500, DJIA and NASDAQ lose 6.94%, 5.07% and 9.2% of their respective index values.

3.129 "World Economic Outlook, April 2018 – Cyclical Upswing, Structural Change", International Monetary Fund. Accessible here: https://www.imf.org/en/Publications/WEO/Issues/2018/03/20/world-economic-outlook-april-2018.

3.130 "World Economic Outlook Update, July 2018 – Less Even Expansion, Rising Trade Tensions", International Monetary Fund. Accessible here: https://www.imf.org/en/Publications/WEO/Issues/2018/07/02/world-economic-outlook-update-july-2018.

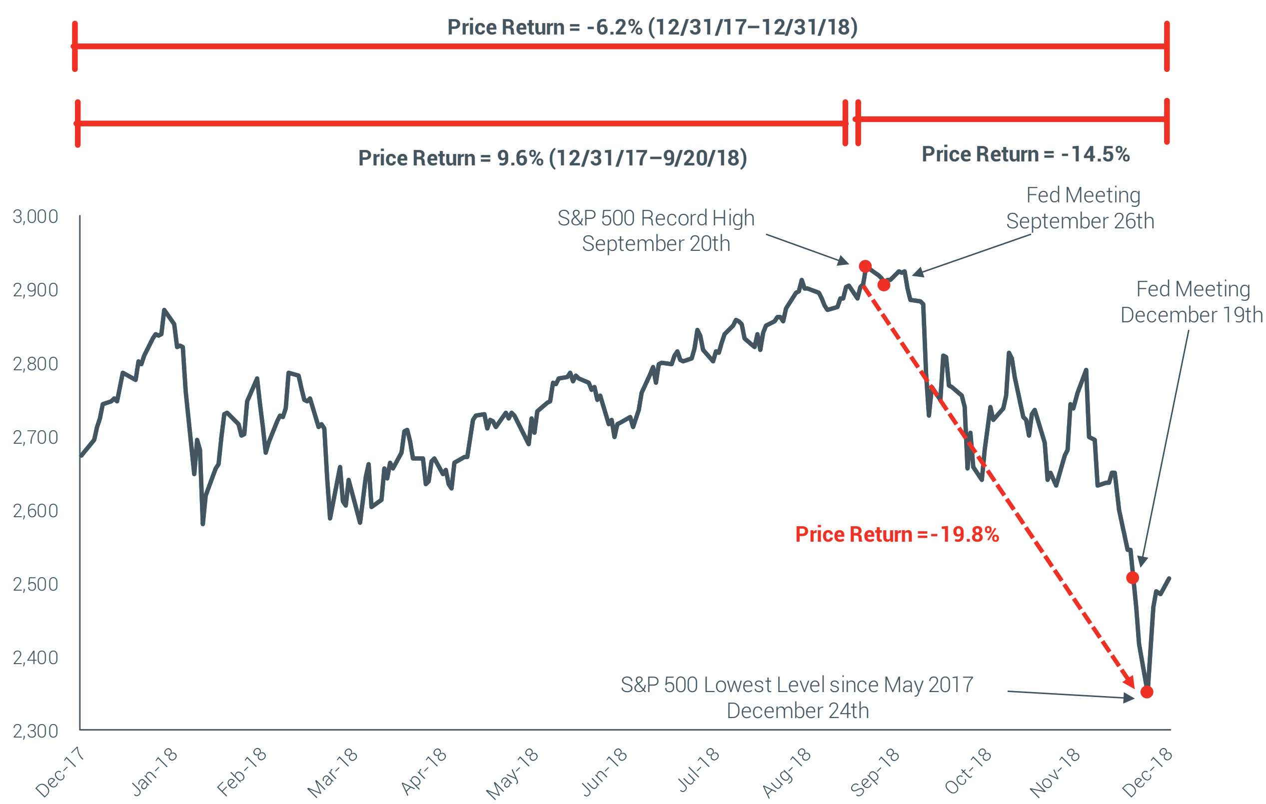
3.131 "World Economic Outlook, October 2018 – Challenges to Steady Growth", International Monetary Fund. Accessible here: https://www.imf.org/en/Publications/WEO/Issues/2018/09/24/world-economic-outlook-october-2018.

3.132 "World Economic Outlook Update, January 2019 – A Weakening Global Expansion", International Monetary Fund. Accessible here : https://www.imf.org/en/Publications/WEO/Issues/2019/01/11/weo-update-january-2019. In its April 2019 update, the IMF projected a slowdown in 2019 growth for 70% of the world economy. The downward revision reflected weaker projected growth for several major economies, including the Eurozone, Latin America, the United Kingdom, Canada, Australia, and even the United States "World Economic Outlook, April 2019 – Growth Slowdown, Precarious Recovery", International Monetary Fund. Accessible here : https://www.imf.org/en/Publications/WEO/Issues/2019/03/28/world-economic-outlook-april-2019.

While major market indices saw negative returns in the month of October, performance was even more dismal in December 2018. As a result, 2018 marked the worst annual performance for U.S. equity markets since the Financial Crisis. Overall, DJIA declined 5.6% (in price terms), whereas the S&P 500 and the NASDAQ lost 6.2% and 3.9% of their respective index values.

As illustrated in Exhibit 3.23, the S&P 500 index gained 9.6% since December 31, 2017 until September 20, 2018, when it reached a record high. Shortly after the Fed's meeting decision on September 26 to raise its benchmark interest rate by 25 b.p., while also showing no intent to slow its path towards normalization, markets reversed their ascent. Losses continued after the Fed's December 19 meeting decision of yet another 25 b.p. hike. Between the record high achieved on September 20 and December 24, the lowest level for the index reached during 2018, the S&P 500 index declined by 19.8%. Some financial market commentators argued that U.S. major equity indices had reached a bear market.[3.133]

Exhibit 3.23: S&P 500 Index Performance (Price Returns), December 31, 2017—December 31, 2018



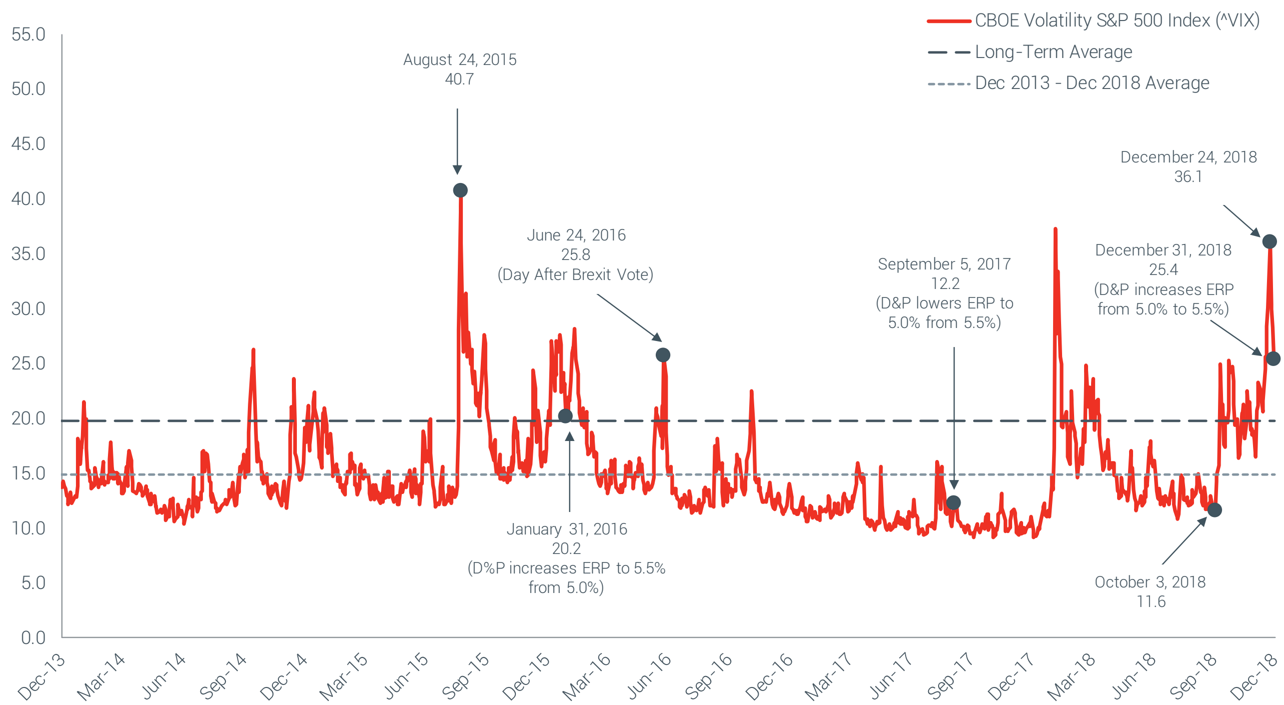
Source of underlying data: S&P *Capital IQ*.

[3.133] See for example, Rooney, Kate. "We are now in a bear market — here's what that means." CNBC.com, December 24, 2018. Available here: https://www.cnbc.com/2018/12/24/whats-a-bear-market-and-how-long-do-they-usually-last-.html.

Implied Equity Volatility

Implied equity volatility, as measured by the Chicago Board Options Exchange (CBOE) "VIX" Index, has been termed a "fear index" as it can be a gauge of investor apprehension. Volatility in the U.S. equities market declined sharply in late January and during 2017. The beginning of 2018 saw a spike in volatility that lasted two months; however strong corporate earnings and the high consumer confidence calmed investors' fears and pushed markets higher. The volatility came back by the end of 2018, investors appear much more nervous about financial markets than earlier in the year. The daily average of VIX during the last quarter of 2018 (21.1) was practically double the average VIX during all of 2017 (11.1). As shown in Exhibit 3.24, during 2018, the VIX Index peaked on December 24, 2018, the same day that the S&P 500 reached its lowest level for the year.

Exhibit 3.24: CBOE Volatility S&P 500 Index (VIX) December 2010–December 2018



Source of underlying data: *S&P Capital IQ.*

Increased volatility may continue into 2019, as investors may be apprehensive about slowing global (and thus U.S.) growth. There are concerns about the state of the economy in China (the second largest economy in the world) that could be aggravated by prolonged trade tensions with the U.S. On the European front, Brexit and French street riots are other events that could rattle the European economy.

World Economy

China,the second biggest economy in the world, is seeing signs of faltering growth that could derail the growth in the U.S. In November 2018, Chinese retail sales grew at their lowest pace in 15 years and factory output saw its weakest level in three years.[3.134] The problems are not only due to the trade tension with the U.S., but there are other structural issues in the Chinese economy that could be a drag on growth: excessive corporate borrowing, reliance on fixed-assets investment and a weak domestic consumption. In 2017, most of the growth in the Chinese economy was fueled by investment and not consumer spending.

The Chinese government knows this all too well and have been trying to stimulate domestic consumption in an effort to curtail the risk exposure of the country to volatility in exports and global investment cycles. Meanwhile, fixed-assets investment has been the biggest driver of the Chinese economy which fuels global demand for commodities and energy. After an infrastructure boom in 2016-2017, the level of infrastructure investment started to dwindle in early 2018 dragging growth with it. China's cabinet instructed local governments to accelerate their infrastructure spending by taking advantage of a new type of infrastructure bonds; however, the issuance of these bonds slowed sharply in October 2018. [3.135]

Excessive borrowing of Chinese private businesses was perceived as an economic threat to the economy that could lead to a systemic crisis in the banking system. The IMF downgraded China's sovereign rating in September 2017, warning that the level of debt was "dangerous".[3.136] China reacted by imposing macroprudential regulation to mitigate these risks. This resulted in a deep financial squeeze for non-state-owned companies, forcing China to nationalize at least 10 struggling private groups in 2018. Ultimately, the Chinese central bank had to cut the reserve ratio and to conduct cash injections into the economy. [3.137]

In Europe, Brexit is the major risk facing the regional economy. The UK and the European Union (EU) agreed upon a draft of what is commonly called "Brexit", but the British parliament was not supportive of the document that its own government negotiated. The main contention, the "Irish backstop clause", was considered by some lawmakers a potential loss of sovereignty of the UK over Northern Ireland.[3.138] Parliament voted against this plan. The British government is between a rock and a hard place: the plan it negotiated over two years with the EU was shot down, and the EU refuses to consider more concessions. Meanwhile, businesses and the government are planning for the worst-case scenario: "no-deal". The "no-deal" scenario threatens the European integrated supply chain of many companies in the manufacturing sector in the UK, the ability to the UK deliver financial services freely in the EU and the end to a customs-free relationship with the EU.

[3.134] Wildau, Gabriel, Jia, Yizhen, Lockett, Hudson and Fleming, Sam. "Chinese Data Showing Slowdown Spook Global Markets," ft.com, December 14, 2018.

[3.135] Wildau, Gabriel "China's response to its slowing economy and the trade war — in charts," ft.com, November 14, 2018.

[3.136] Wildau, Gabriel. "Beijing effort and inflation push China debt load down," ft.com, September 24, 2017.

[3.137] Wildau, Gabriel "China's response to its slowing economy and the trade war — in charts," ft.com, November 14, 2018.

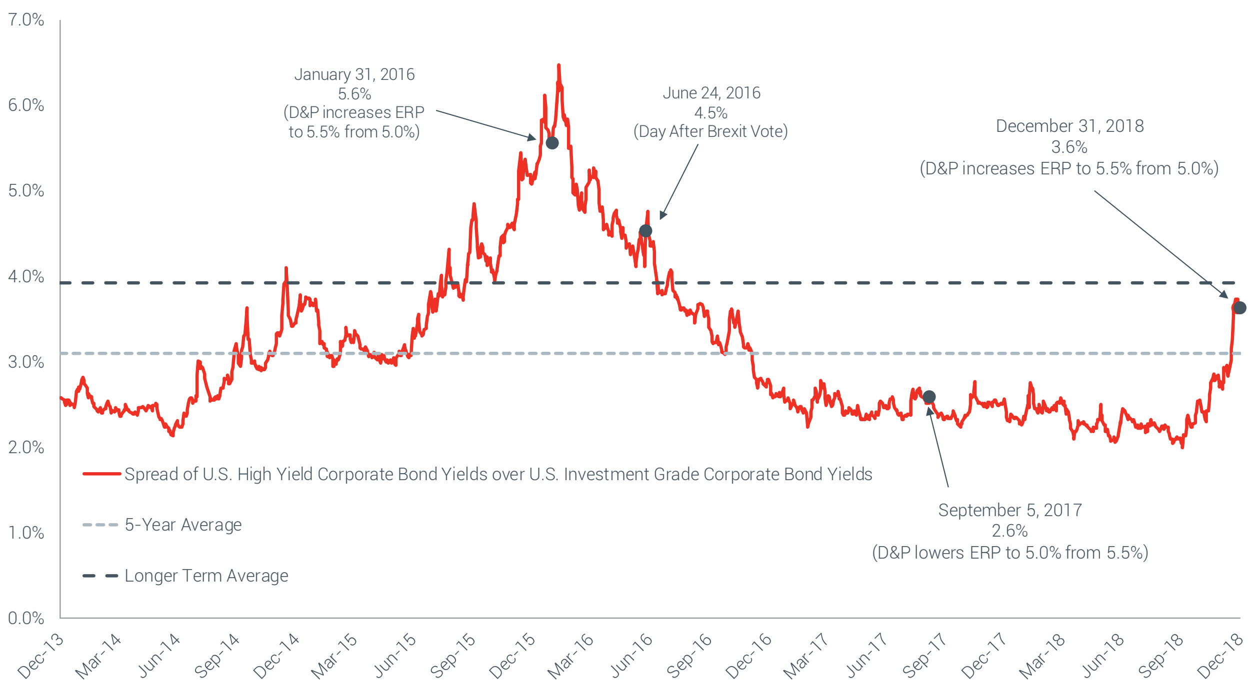
[3.138] After Brexit, the borders between Northern Ireland and the Republic of Ireland would be the only borders between the EU and the UK. These borders were abolished as part of the 1998 Belfast Agreement that brought peace to Northern Ireland. Brexit would require that the EU and the UK find a solution for the movement of goods and people without physical border. The backstop was proposed an insurance policy guaranteeing that no physical borders on the island of Ireland, but it would imply that Northern Ireland would remain fully aligned with the EU's customs union. For more details see: https://www.irishtimes.com/news/politics/brexit-explained-why-does-the-border-matter-and-what-is-the-backstop-1.3661518

On the other side of the English Channel, the French economy suffered from a wave of protests against the government.[3.139] The imposition of a green tax on gas turned some of the population against French President Emmanuel Macron, and led to widespread protests in the streets. The protests spontaneously erupted and were dubbed the "yellow vests protests" in reference to the visible yellow vests that motorists are required to carry. These street protests ultimately forced the government to reverse course and scrap the tax, but the protesters increased the ceiling of their demands and started to call of the resignation of Mr. Macron.[3.140]

Corporate Credit Spreads

Relative to December 2017, U.S. corporate credit spreads have widened substantially by year-end 2018 (see Exhibit 3.25). However, the surge in borrowing costs for non-investment grade (i.e., high-yield) corporate borrowers did not start until the fourth quarter of 2018. In fact, on October 3, 2018 (shortly after equity markets reached a new record high) the credit spread of U.S. high-yield over investment-grade corporate bonds reached its lowest level since July 2007, prior to the onset of the Financial Crisis.

Exhibit 3.25: Spread of U.S. High Yield Corporate Bond Yields over U.S. Investment Grade Corporate Bond Yields December 2012–December 2018



Source of underlying data: S&P *Capital IQ*

Since the onset of the Financial Crisis, fixed income markets have been significant beneficiaries of the QE policies implemented by major central banks across the globe. Large asset purchases by

[3.139] For more details about the impact of these protests on the French economy, see: https://www.france24.com/en/20181203-yellow-vest-protests-french-economy-business-retail-peugeot-citroen-le-maire.

[3.140] McAuley, James "Why are the 'yellow vests' still protesting in France? His name is Macron," *Washington Post*, December 8, 2018. Accessed here: https://www.washingtonpost.com/world/europe/why-are-the-yellow-vests-still-protesting-in-france-his-name-is-macron/2018/12/08/36488d00-fa2d-11e8-8642-c9718a256cbd_story.html?utm_term=.0a9e4ead30aa.

central banks have created an environment of ultra-low interest rates, encouraging new corporate debt issuance on a global basis. In addition, QE programs in the Eurozone, United Kingdom, and Japan include investment-grade corporate debt securities, thereby decreasing borrowing costs for those corporations even further.

As mentioned earlier, a variety of factors, including the Fed's continued path towards monetary policy tightening, U.S. trade policy uncertainties (especially with China), signs of a global economic slowdown, and concerns about the outlook for corporate earnings all contributed to a deterioration in risk sentiment early in the fourth quarter of 2018. During this time, corporate bond spreads widened notably, particularly in December. In fact, in December 2018 the volume of high-yield bonds issued by nonfinancial firms dropped to zero, the first time that happened since 2008, according to data-provider Dealogic.[3.141]

Quantitative Models

In addition to the general economic factors and financial market conditions described above, we examine other indicators that may provide a more quantitative view of where we are within the range of reasonable long-term estimates for the U.S. ERP. Duff & Phelps currently uses several models as corroborating evidence. We reviewed these indicators at year-end 2018.

Damodaran Implied ERP Model

Professor Aswath Damodaran calculates implied ERP estimates for the S&P 500 Index and publishes his estimates on his website. Prof. Damodaran estimates an implied ERP by first solving for the discount rate that equates the current S&P 500 Index level with his estimates of cash distributions (dividends and stock buybacks) in future years. He then subtracts the current yield on 10-year U.S. government bonds to arrive at an implied ERP.

In 2014, Prof. Damodaran introduced new capabilities to his implied equity risk premium calculator. The new features allow the user to select a variety of base projected cash flow yields, as a well as several expected growth rate choices for the following five years in the forecast. Each option for cash flow yields is independent of the growth rate assumptions, which means that the user can select up to 35 different combinations to estimate an implied ERP. In early 2016, Prof. Damodaran added a new feature that allows the terminal year's projected cash flows to be adjusted to what he considers a more sustainable payout ratio. This sustainable payout is computed using the long-term growth rate (g) and the trailing 12-month return on equity (ROE), as follows: Sustainable Payout = 1 – g/ROE. If the user selects this option, the payout ratio over the next (projected) five years is based on a linear interpolation between today's payout ratio and the Sustainable Payout. Otherwise, the terminal year payout ratio will be the same as today's value throughout the entire forecast. Exhibit 3.27 shows the current options that a user can select to arrive at an implied ERP indication. Each of these combinations can then be adjusted for a sustainable payout, if the user so decides.

[3.141] Egan, Matt, "Why Wall Street turned its back on junk bonds", CNN Business, Updated January 11, 2019. Accessed here: https://www.cnn.com/2019/01/11/investing/junk-bonds-markets-debt.

Duff & Phelps converts Prof. Damodaran's estimates to an arithmetic average equivalent measured against the 20-year U.S. government bond yield, relying primarily on two measures of projected cash flows: (i) the trailing 12-month cash flow yield (dividends plus buybacks) of S&P 500 constituents; and (ii) the trailing 10-year average cash flow yield (dividends plus buybacks) of S&P 500 constituents.

Exhibit 3.27: Professor Damodaran's Implied Equity Risk Premium Calculator Cash Flow Yield (Dividends + Buybacks) and Growth Rate Options

S&P 500 Cash Flow Yield (Dividends + Buybacks)	S&P Earnings Growth Rates for Years 1 through 5 in the Projections	Adjustment for Sustainable Payout
Trailing 12-months Dividend + Buyback Yield	Historical Growth Rate for the last 10 years	Adjust Cash Flow Yield for Sustainable Payout
Average Dividend + Buyback Yield for the last 10 years	Bottom-up Forecasted Growth Rate for next 5 years (with growth in the 5th year assumed to be equal to the current 10-year U.S. Treasury yield)	Do Not Adjust Cash Flow Yield for Sustainable Payout
Average Dividend + Buyback Yield for the last 5 years	Top-Down Forecasted Growth Rate for next 5 years (with growth in the 5th year assumed to be equal to the current 10-year U.S. Treasury yield)	
Average Payout for the last 10 years, multiplied by Trailing 12-month Earnings	Fundamental Growth Rate (i.e., Earnings Retention Rate * Current ROE)	
Average Payout for the last 5 years, multiplied by Trailing 12-month Earnings	Fundamental Growth Rate (i.e., Earnings Retention Rate * 10-year Average ROE)	
Average Payout for the last 10 years, using S&P 500 Normalized Earnings		
Trailing 12-month Dividend + Buyback Yield, Net of Stock Issuance		

Source of underlying data: Downloadable dataset entitled "Spreadsheet to compute ERP". To obtain a copy, visit: http://people.stern.nyu.edu/adamodar/.

Based on Prof. Damodaran's estimates of the trailing 12-month cash flow yield, the implied ERP (converted into an arithmetic average equivalent) was approximately 7.20% at end of December 2018, when measured against an abnormally low 20-year U.S. government bond yield (2.87%).[3.142] The equivalent normalized implied ERP estimate was 6.57% measured against a normalized 20-year U.S. government bond yield of 3.5%. This normalized implied ERP estimates represent an increase of 118 b.p., relative to the December 2017 estimate (5.38%). The normalized implied ERP indications were even higher in October and November 2018 (using the same methodology).

Default Spread Model (DSM)

The Default Spread Model is based on the premise that the long-term average ERP (the unconditional ERP) is constant and deviations from that average over an economic cycle can be measured by reference to deviations from the long-term average of the default spread between corporate bonds rated in the Baa category by Moody's versus those in the Aaa rating category. This model notably removes the risk-free rate itself as an input in the estimation of ERP.[3.143] However, the ERP indication resulting from the DSM is still interpreted as an estimate of the relative return of stocks in excess of risk-free securities.

At the end of December 2018, the conditional ERP calculated using the DSM model was 5.37%. This represents an increase of 44 b.p., relative to the 4.93% ERP indication at the end of December 2017. For perspective, March 2016 was the last time that the conditional ERP calculated using the DSM model was this high. As a reminder, this was also around the same time Duff & Phelps had increased its U.S. recommended ERP from 5.0% to 5.5%.[3.144]

[3.142] Damodaran's implied rate of return (based on the actual 10-year yield) on the S&P 500 = 8.65% as of January 1, 2019, minus the actual 20-year U.S. Treasury yield of 2.87% plus an adjustment to equate the geometric average ERP to its arithmetic equivalent. The result reflects conversion of the implied ERP to an arithmetic average equivalent. For more details on this adjustment, refer to Chapter 3 of the Duff & Phelps *2019 Valuation Handbook – U.S. Guide to Cost of Capital*, available online in the Duff & Phelps Cost of Capital Navigator at dpcostofcapital.com.

[3.143] The Default Spread Model presented herein is based on Jagannathan, Ravi, and Wang, Zhenyu," The Conditional CAPM and the Cross -Section of Expected Returns," *The Journal of Finance*, Volume 51, Issue 1, March 1996: 3–53. See also Elton, Edwin J. and Gruber, Martin J., Agrawal, Deepak, and Mann, Christopher "Is There a Risk Premium in Corporate bonds?", Working Paper, http://people.stern.nyu.edu/eelton/working_papers/Is_there_a_risk_premium_in_corporate_bonds_2.pdf. Duff & Phelps uses (as did Jagannathan, Ravi, and Wang) the spread of high-grade corporates (proxied by yields on Aaa rated bonds) against lesser grade corporates (proxied by yields on Baa rated bonds). Corporate bond series used in analysis herein: Bloomberg Barclays US Corp Baa Long Yld USD (Yield) and Bloomberg Barclays US Corp Aaa Long Yld USD (Yield); Source: Morningstar Direct.

[3.144] Refer to the Duff & Phelps Client Alert issued on March 16, 2016 and titled "Duff & Phelps Increases U.S. Equity Risk Premium Recommendation to 5.5%, Effective January 31, 2016". To obtain a free copy of this Client Alert and prior ones documenting the Duff & Phelps' U.S. ERP recommendation over time, visit: www.DuffandPhelps.com/CostofCapital.

Note that in periods where corporate default spreads for investment-grade bonds (i.e., those in the Aaa through Baa rating categories) are significantly compressed due to investor demand for yield (i.e., a search for a current yield-producing investment) in a high-quality, lower risk asset class, the DSM model may result in ERP indications less consistent with the risk perceived in equity markets.[3.145] This appears to be the case in the months leading up to December 2016. This was also the case back in 2011, for example, in the midst of the Euro sovereign debt crisis, where other ERP indicators pointed to high risk in equity markets, but the DSM model indicated an ERP close to the long-term unconditional ERP (5.5% as applied by Duff & Phelps, as of December 31, 2018).

Hassett Implied ERP (Hassett)

Stephen Hassett has developed a model for estimating the implied ERP, as well as the estimated S&P 500 index level, based on the current yield on long-term U.S. government bonds and a risk premium factor (RPF).[3.146] The RPF is the empirically derived relationship between the risk-free rate, S&P 500 earnings, real interest rates, and real GDP growth to the S&P 500 index over time. The RPF appears to change only infrequently. The model can be used monthly to estimate the S&P 500 Index level and the conditional ERP based on the current level of interest rates.[3.147]

Hassett's analysis uses the spot 10-year risk free rate for the period from January 2008 through July 2011; thereafter, his analysis uses a normalized yield on U.S. government bond of 4.0% (2.0% real risk-free rate plus 2.0% inflation) and 4.5% (2.0% real risk-free rate plus 2.5% inflation).[3.148] As of December 31, 2018, Hassett model's predicts that the S&P 500 index appears to be undervalued by 17.7% using a normalized risk-free rate of 4.5% or undervalued by 3.3% using a normalized risk-free rate of 4.0%.[3.149] Alternatively, based on the S&P 500 Index level at the end of December 2018, Hassett model's infers long-term 10-year U.S. bond yield at 4.63%. He concludes that if earnings do not change much during 2019, further increases in long-term yields will not affect equity markets.

While these additional models may be useful in suggesting the direction of changes in the conditional ERP, they are, like *all* methods of estimating the ERP, imperfect. Both the Damodaran Implied ERP Model, the Default Spread Model, and the Hassett model utilize assumptions that are subjective in nature. For example, the Damodaran Implied ERP Model assumes a long-term growth

[3.145] Also, note that returns on below-investment grade corporate bonds (a.k.a., "high-yield" or "junk" bonds) tend to move more closely with equity returns than do investment-grade corporate bonds. See for example S&P Global Market Intelligence Fridson's newsletter from November 2, 2016 entitled "Stocks versus HY bonds, plus monthly recap". In this Newsletter, analyst Marty Fridson stated that "…stocks and high-yield bonds do tend to move together. For the 29 years (1987–2015) for which full-year returns are available on the BofA Merrill Lynch US High Yield Index, its annual total return correlation with the S&P 500 is 65%." In addition, Fridson discussed the impact of a strong search for yield, which led to significantly higher returns for junk bonds (and correspondingly lower yields) in the January–October 2016 period than expected for this asset class (bond prices move in opposite direction to yields). So, just prior to the U.S. presidential election on November 8, 2016, when stock markets had shown lackluster performance for the year, Fridson wrote that "(w)e hypothesize that high-yield bonds have responded more dramatically than stocks – and excessively – to this year's improvement in economic and financial conditions because of investors' desperate search for yield. Stocks, other than this year's strongly performing high-dividend variety, do not satisfy that appetite."

[3.146] Stephen D. Hassett, ''The RPF Model for Calculating the Equity Risk Premium and Explaining the Value of the S&P with Two Variables,'' *Journal of Applied Corporate Finance* 22, 2 (Spring 2010): 118–130.

[3.147] For a more detailed description of Hassett's Risk Premium Factor model see Pratt and Grabowski, op.cit., Chapter 8A, "Deriving ERP Estimates": 167 168".

[3.148] To confirm, Stephen Hassett uses a 2.0% real rate in his analysis for a normalized yield on U.S. Treasuries. As discussed previously and illustrated in Exhibit 3.14, Duff & Phelps uses a range of 0.0% to 2.0% for the long-term real rate.

[3.149] "RPF Model Has S&P 500 Ending 2018 Undervalued With 4%+ 10-Year Factored In", January 8, 2019, by Steve Hassett, Retrieved from: https://seekingalpha.com/article/4232013-rpf-model-s-and-p-500-ending-2018-undervalued-4-percent-10-year-factored rate for dividends and buybacks that is largely a matter of judgment. Likewise, in the Default Spread Model, the changes in spread are applied to a "benchmark" ERP estimate; the choice of that benchmark ERP is largely a matter of judgment.

Again, the inherent "imperfection" of any single ERP estimation model is precisely why Duff & Phelps takes into account a *broad* range of economic information and *multiple* ERP estimation methodologies to arrive at our conditional ERP recommendation.

Concluding on an ERP

What is a reasonable estimate of the *unconditional* or long-term average ERP for the United States as of December 31, 2018?

Based on the various models and indicators described above, we have summarized in Exhibit 3.28 the quantitative ERP evidence (expressed in terms of arithmetic averages), which we then used as support for our concluded U.S. ERP.

Exhibit 3.28: Historical and Implied U.S. ERP Estimates as of December 31, 2018

ERP Estimate	Arithmetic Average (%)
Historical Estimates	
Historical Long-term ERP (1926–2018)	6.91
Historical Long-term ERP adjusted for WWII Interest Rate Bias	5.86
Supply-side Long-term ERP (1926–2018)	6.14
Supply-side Long-term ERP adjusted for WWII Interest Rate Bias	5.09
Implied Estimates	
Damodaran Implied ERP (trailing 12-month, measured against a normalized RF of 3.5%)	6.57
Default Spread Model Implied ERP	5.37

Some valuation analysts express dismay over the necessity of considering a forward ERP since that would require changing their current cookbook practice of relying exclusively on the post-1925 historical arithmetic average of one-year realized risk premiums as their estimate of the ERP.

Yet, valuation is a forward-looking concept, not an exercise in mechanical application of formulas. Correct valuation methodology requires applying value drivers reflected in today's market pricing. We need to mimic the market. In our experience, you often cannot match current market pricing for equities using the post-1925 historical arithmetic average of one-year realized premiums as the basis for developing discount rates. The entire valuation process is based on applying reasoned judgment to the evidence derived from economic, financial, and other information and arriving at a well-reasoned opinion of value. Estimating the ERP is no different.

[3.150] Siegel, Laurence B., "The Equity Risk Premium: A Contextual Literature Review", CFA Institute Research Foundation Volume 12, Issue 1, November 2017, ISBN: 978-1-944960-31-5: 9.

Conclusion

Based on current market conditions, we find sufficient evidence to conclude on a *conditional* U.S. ERP of 5.5%, for valuation dates as of December 31, 2018 and thereafter (see Exhibit 3.29). We will maintain our recommendation to use a 5.5% U.S. ERP when developing discount rates until there is evidence indicating equity risk in financial markets has materially changed.

The current ERP recommendation was developed in conjunction with a "normalized" 20-year yield on U.S. government bonds as a proxy for the risk-free rate. Based on academic literature and market evidence of a secular decrease in real interest rates (a.k.a. the "rental" rate) and lower long-term real GDP growth estimates for the U.S. economy, we are reaffirming our concluded normalized risk-free rate of 3.5%, established as of November 15, 2016. However, as indicated earlier, we are monitoring market conditions and will evaluate when risk-free rate normalization may no longer be appropriate.

The ERPs in Exhibits 3.28 and 3.29 are expressed in terms of an arithmetic average equivalent, which is appropriate for estimating single period discount rates for discounting net cash flows to present value (e.g., the build-up method and the CAPM).

The combination of the reaffirmed U.S. recommended ERP (5.5%) and normalized risk-free rate (3.5%) results in an implied U.S. "base" cost of equity capital estimate of 9.0% (5.5% + 3.5%).

Were we to use the spot yield-to-maturity on 20-year U.S. government bond as of December 31, 2018, one would have to increase the ERP assumption accordingly. One can determine the ERP against the spot 20-year yield inferred by Duff & Phelps' recommended U.S. ERP (used in conjunction with the normalized risk-free rate), by using the following formula:

U.S. ERP Against Spot 20-Year Yield (Inferred) =
+ D&P Recommended U.S. ERP
+ Normalized Risk-Free Rate
– Spot 20-Year U.S. government bond Yield

Using this formula, the following example illustrates the inferred ERP as of December 31, 2018:

	Inferred US ERP		Duff & Phelps Recommended ERP		Normalized Risk-free Rate		Spot 20-Year Treasury Yield
December 31, 2018	6.1%	=	5.5%	+	3.5%	–	2.9%

Duff & Phelps continues to monitor changes in the risk-free rate and expected ERP and periodically updates its recommendations as conditions warrant. But we recognize that some indicators that we rely upon will fluctuate on a month-to-month basis. We believe that minor movements in such indicators often reflect market noise and are not statistically meaningful. We believe that users of our data prefer ERP estimates that do not cause the cost of equity to fluctuate on a month-to-month basis by relatively meaningless amounts. That would imply a precision in ERP estimates that we cannot possibly offer, given the very nature of the wide range of inputs and data we utilize as support to our conclusion. Therefore, we have adopted a methodology where upon we only change our U.S. ERP recommendation when the aggregate evidence supports a change in such ERP that would result in at least a 50-basis-point change to the cost of equity.

Exhibit 3.29: Duff & Phelps Recommended U.S. ERP and Corresponding Risk-Free Rates January 2008–Present

Date	Risk-free Rate (R_f)	R_f (%)	Duff & Phelps Recommended ERP (%)	What Changed
Current Guidance:				
December 31, 2018 – UNTIL FURTHER NOTICE	**Normalized 20-year U.S. Treasury yield**	**3.50**	**5.50**	**ERP**
September 5, 2017 – December 30, 2018	Normalized 20-year U.S. Treasury yield	3.50	5.00	ERP
November 15, 2016 – September 4, 2017	Normalized 20-year U.S. Treasury yield	3.50	5.50	R_f
January 31, 2016 – November 14, 2016	Normalized 20-year U.S. Treasury yield	4.00	5.50	ERP
December 31, 2015	Normalized 20-year U.S. Treasury yield	4.00	5.00	
December 31, 2014	Normalized 20-year U.S. Treasury yield	4.00	5.00	
December 31, 2013	Normalized 20-year U.S. Treasury yield	4.00	5.00	
February 28, 2013 – January 30, 2016	Normalized 20-year U.S. Treasury yield	4.00	5.00	ERP
December 31, 2012	Normalized 20-year U.S. Treasury yield	4.00	5.50	
January 15, 2012 – February 27, 2013	Normalized 20-year U.S. Treasury yield	4.00	5.50	ERP
December 31, 2011	Normalized 20-year U.S. Treasury yield	4.00	6.00	
September 30, 2011 – January 14, 2012	Normalized 20-year U.S. Treasury yield	4.00	6.00	ERP
July 1 2011 – September 29, 2011	Normalized 20-year U.S. Treasury yield	4.00	5.50	R_f
June 1, 2011 – June 30, 2011	Spot 20-year U.S. Treasury yield	Spot	5.50	R_f
May 1, 2011 – May 31, 2011	Normalized 20-year U.S. Treasury yield	4.00	5.50	R_f
December 31, 2010	Spot 20-year U.S. Treasury yield	Spot	5.50	
December 1, 2010 – April 30, 2011	Spot 20-year U.S. Treasury yield	Spot	5.50	R_f
June 1, 2010 – November 30, 2010	Normalized 20-year U.S. Treasury yield	4.00	5.50	R_f
December 31, 2009	Spot 20-year U.S. Treasury yield	Spot	5.50	
December 1, 2009 – May 31, 2010	Spot 20-year U.S. Treasury yield	Spot	5.50	ERP
June 1, 2009 – November 30, 2009	Spot 20-year U.S. Treasury yield	Spot	6.00	R_f
December 31, 2008	Normalized 20-year U.S. Treasury yield	4.50	6.00	
November 1, 2008 – May 31, 2009	Normalized 20-year U.S. Treasury yield	4.50	6.00	R_f
October 27, 2008 – October 31, 2008	Spot 20-year U.S. Treasury yield	Spot	6.00	ERP
January 1, 2008 – October 26, 2008	Spot 20-year U.S. Treasury yield	Spot	5.00	Initialized

Normalized in this context means that in months where the risk-free rate is deemed to be abnormally low, a proxy for a longer-term sustainable risk-free rate is used. To ensure you are always using the most recent ERP recommendation, visit: www.DuffandPhelps.com/CostofCapital.