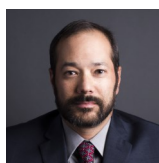




The Power of Copper-Gold: A Leading Indicator for the 10-Year Treasury Yield



Jeffrey M. Mayberry

Co-Portfolio Manager,
Member of DoubleLine's Macro-Asset Allocation Team

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Introduction

The distinct roles of copper versus gold – the red metal’s industrial necessity, the popular perception of the yellow metal as a safe haven – can embed useful information in their market prices, particularly in relationship to each other. Broadly speaking, the ratio of copper to gold can serve as an indicator of the market’s appetite for risk assets versus the perceived safety of Treasuries. More specifically, the ratio of copper to gold can serve as a leading indicator of the direction of the yield on the 10-year U.S. Treasury note.

Smelted from mineral ore for over 10,000 years, copper became the first metal worked by humans. Around 6,500 years ago, someone mixed a secondary metal with copper to invent bronze. An alloy with such useful properties as hardness, ductility and corrosion-resistance, bronze ended the Stone Age, giving its name to the next great technological era of civilization.¹ Its ancient pedigree notwithstanding, copper is indispensable to our modern economy. On a mass scale, generation and transmission of electricity, electrical devices and electronics would be impossible without the red metal. From the Bronze Age into our own Information Age, copper and its alloys have ranked among the foremost commodity inputs to industrial activity.

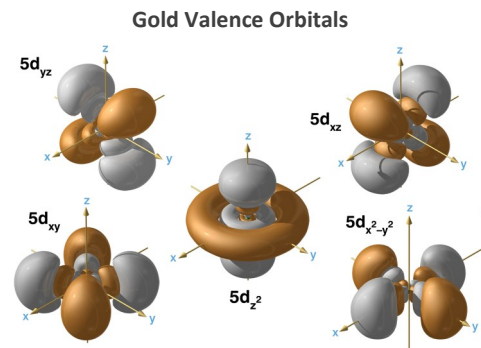
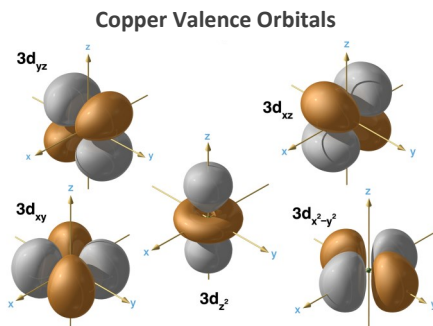
Gold’s credentials are not industrial but financial. Five thousand years ago, the ancient Egyptians organized the first large-scale gold mines. They also set the first gold standard, fixing its exchange rate in terms of multiples of silver.² Gold has retained its primacy atop the precious-metals pecking order ever since, including after the first minting of gold and silver coins in the 6th century BC.³ Two millennia would pass before negotiable credit instruments and later forms of paper money would appear and start to displace specie as a medium of exchange. With booming international trade in the mid-1800s, the major trading countries turned to paper money for its convenience. Gold, however, remained the linchpin of the monetary order. Sovereign governments agreed to redeem their paper in the yellow metal at predetermined rates of exchange. Albeit with interruptions, the gold standard persisted well into the 20th century.^{4,5} Even today, decades after the abandonment of the gold standard and the proliferation of fiat currencies, the monarch of metals still exacts a form of tribute from paper and computer blips. Rightly or wrongly, more than any other commodity, gold endures in our minds as a store of wealth when the times shake our faith in fiat money.⁶

All That Glitters

To the unaided eye, any substance which does not emit light takes the color of the visible wavelengths of light which it reflects. Most metals absorb and then re-emit most of the visible wavelengths, causing them to appear silvery or gray. Copper and gold are different; each element absorbs and reflects distinct parts of the visible spectrum. Copper absorbs blue-green light and reflects red-orange. Gold appears yellow because it absorbs yellow’s color complement: blue.

The color of any element is determined by its atomic structure. Under modern atomic theory, the structure of each element comprises a positively charged nucleus within a vastly greater volume formed by one or more orbitals of electrons. For example, the most common isotope of hydrogen, the lightest of the elements, has a nucleus of one proton with a single electron. Successively heavier elements contain nuclei of multiple particles, including neutrons and positively charged protons, surrounded by orbitals of negatively charged electrons.

The outermost orbitals are the valence orbitals. Electrons tend to stay on the lowest-energy (or most inner) levels possible. However, absorption of energy, including visible light particles called photons, can “excite” electrons to higher energy levels. The different valence electron configurations of copper and gold account for the differences in the “energy jumps” of their electrons. As a result, the two elements absorb and reflect photons in different parts of the spectrum.



Images courtesy of Carlos Clarivan/Science Photo Library

Gold’s electron configuration, as explained by Albert Einstein’s theory of relativity, also holds the key to why gold retains its glitter or glow while other metals such as copper and silver tarnish. But that’s another story.

*Fan Zhang, Ph.D. in physics, UCLA
Information Technology Department, DoubleLine*

Introduction (cont'd)

The copper-gold ratio is the quotient obtained by division of the price per pound of copper by the price per troy ounce of gold (31.1 grams). (Figure 1) The ratio's absolute level is irrelevant. What matters is its direction – and whether the yield on the 10-year Treasury moved in the same direction or diverged. In past episodes of divergence, the 10-year yield has eventually tended to follow suit of copper-gold.

The power of copper-gold, however, is not absolute. All market indicators are subject to “noise,” or volatility with no useful signals. As a result, these gauges can flash “false positives” or “false negatives.” Copper-gold likewise can send miscues at times. With those caveats in mind, copper-gold merits a place on DoubleLine’s dashboard of market gauges.

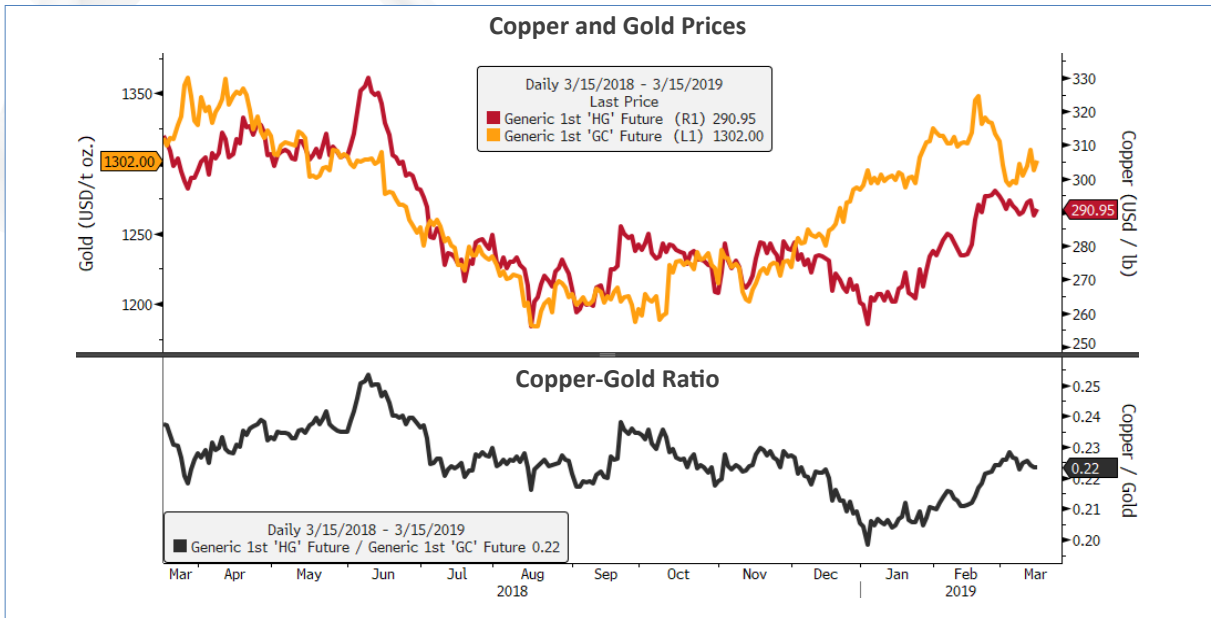


Figure 1. Source: DoubleLine, Bloomberg
The upper chart plots the price of gold in dollars per troy ounce (gold line, left axis) and the price of copper in cents per pound (red line, right axis) over time; the lower chart plots the ratio of the two prices over the same timeframe.

Why Copper-Gold Works

The predictive power of copper-gold stems from the distinct roles of industrial versus precious metals, the former rooted in the physical economy and the latter in finance.

Thanks to such properties as electrical and thermal conductivity, machinability, ductility and corrosion resistance, copper and copper alloys are used for wiring, piping, shielding, heat sinks, radiators and myriad other necessities related to manufacturing and construction as well as the generation, transmission and application of electricity. The new economy would be unimaginable without copper. The commodity is used in circuit boards, integrated circuits, electrical motors now entering automobiles and even renewable energy technologies such as wind turbines and solar panels.⁷

Copper	Gold
<ul style="list-style-type: none"> “Doctor Copper” Proxy for economic growth Used by cyclical industries (manufacturing, construction) 	<ul style="list-style-type: none"> Popular perception as safe haven Flight to quality Store of wealth
Times of Economic Growth/Rising GDP <ul style="list-style-type: none"> Risk on Copper prices up (rising demand) Gold prices down (more return potential in other assets) Ratio up 10-year yields up/ Fed raising Fed Funds rate 	Recession Warnings/Slowing Growth <ul style="list-style-type: none"> Risk off Copper prices down (slowing demand) Gold prices up (buy safer assets; emphasis: capital preservation) Ratio down 10-year yields down/ Fed cuts Fed Funds rate

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Why Copper-Gold Works (cont'd)

New high-speed trains can require “anywhere from 2 to 4 tonnes of copper, significantly higher than the 1 to 2 tonnes used in traditional electric trains.”⁸ Copper is important to the health of plants, animals and humans. It even has antimicrobial properties, making it useful as an anti-pathogen.⁹

According to the International Copper Study Group, growth markets for the red metal include medical applications, aquaculture, electrical propulsion (infrastructure as well as vehicles), renewable energy systems, kinetic energy-absorbing materials to limit the motion of buildings during seismic events and ultra-conductive nanocarbon/copper components for increased efficiency in electrical energy transmission and distribution. Another source of incremental demand for copper is expected from Asia, Africa, Central America and South America as countries on those continents build their infrastructure and grow their economies.

Despite the projected growth in demand, copper shortages are unlikely given the size of identified copper resources and vast amounts of copper believed to await discovery. Since 1950, according to U.S. Geological Survey data, “there has always been, on average, 40 years of [global] reserves, and significantly greater amounts of known resources.... In addition, recycling, innovation and mining exploration continue to contribute to the long-term availability of copper.”¹⁰

Demand for copper is highly sensitive to changes in global economic growth. As result, copper prices reflect changes in growth or growth expectations. Economic growth increases industrial demand for the metal, raising prices. Economic weakness saps demand, lowering prices. Hence “Doctor Copper” is a proxy for economic health. (Figure 2)

It’s worth noting that the world’s second-largest economy is also its largest consumer of copper: China consumes more than 40% of the world’s copper supply. Erik Norland, executive director and senior economist of the Chicago Mercantile Exchange Group, has observed that copper prices correlate closely with the China Li Keqiang Index.¹¹ The index, developed by Bloomberg as a proxy of China’s gross domestic product, is a composite of bank loans, rail freight volume and electricity production.¹² (Figure 3)

Due to its scarcity and softness, gold has almost no industrial utility outside of niche applications. Of this ironic inutility, historian and economist Peter Bernstein wrote, “Is that not strange? Out of steel we can build office towers, ships, automobiles, containers, and machinery of all types; out of gold, we can build nothing. And yet it is gold that we call the precious metal. We yearn for gold and yawn at steel. When all the steel has rusted and rotted, and forever after that, your great cube of gold will still look like new. That is the kind of longevity we all dream of.”¹³

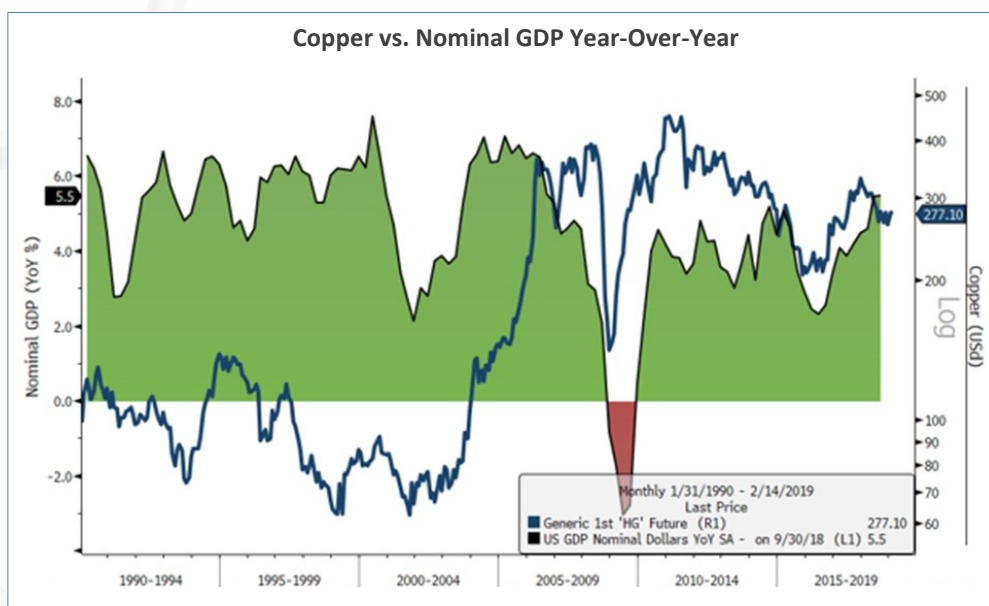
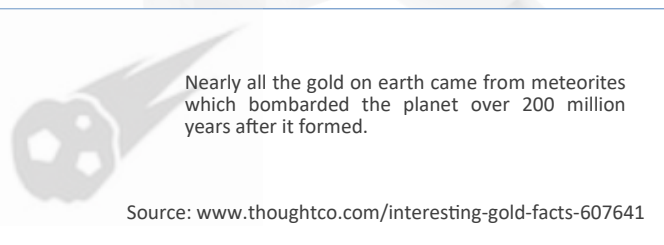


Figure 2. Source: DoubleLine, Bloomberg



The Power of Copper-Gold: A Leading Indicator for the 10-Year Treasury Yield

Why Copper-Gold Works (cont'd)

Gold's financial power stems from a serendipitous union of properties, the first being its virtual indestructibility. Immune to chemical change, nearly all the gold ever extracted from the earth exists today.¹⁴ Second is density. By atomic mass, gold is nearly as massive (and thus heavy) as lead.¹⁵ Gold is scarce. Humans have extracted perhaps 200,000 tons in all of history.¹⁶ By comparison, Chile, producer of one third of the world's copper, mined 5.33 million tons of the red metal in 2017 alone.¹⁷ With these physical properties comes an intangible but undeniable psychological factor: charisma. No commodity has held more enduring sway over humanity's imagination than has gold. Thanks to its immutability, mass, rarity and allure, gold can store far more wealth by weight than silver or any of the industrial metals.¹⁸

Gold has a popular reputation as a safe haven in times of heightened concern over debasement of the U.S. dollar or perils to the banking system. Claude Erb and Campbell Harvey (2013, see bibliography) have shown that gold has not lived up to this reputation. The positive "evidence" for gold as an inflation or currency hedge is at best anecdotal.

An episode of gold as debasement hedge occurred during unusually high inflation afflicting the U.S. in the late 1970s-early 1980s.¹⁹ Perhaps an example of gold as a safe haven amid banking concerns occurred in 2009-2012 during the massive balance-sheet expansion at the Federal Reserve. (Figure 4)



Figure 3. Source: DoubleLine, Bloomberg

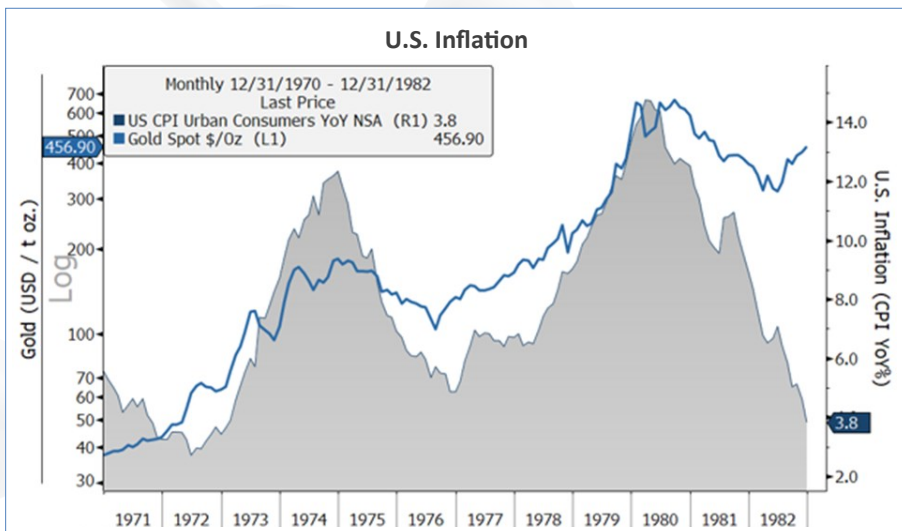
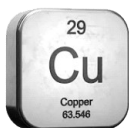


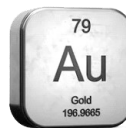
Figure 4. Source: DoubleLine, Bloomberg



We're in no danger of running out of copper. Worldwide resources of this important metal are estimated at more than 8.1 trillion pounds of which only about 1.1 trillion (13.6%) have been mined throughout history.

Archeologists recovered a portion of the water plumbing system from the Pyramid of Cheops in Egypt. The copper tubing remained in serviceable condition after more than 5,000 years.

Source: www.copper.org



The element symbol for gold, Au, comes from the Latin name for gold, aurum, which means "shining dawn" or "glow of sunrise." The word "gold" comes from the Germanic languages, originating from the Proto-Germanic gulþ and Proto-Indo-European ghel, meaning "yellow/green."

Source: www.thoughtco.com/interesting-gold-facts-607641

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Copper-Gold and the 10-Year Treasury Yield: Case Histories

The direction of the copper-gold ratio can sometimes lead the direction of the 10-year Treasury yield when copper-gold moves higher or lower against a divergence by the 10-year yield. In past episodes of divergence, the 10-year yield has eventually tended to “capitulate” and move in the same direction as copper-gold.

On June 7, 2010, copper-gold hit a relative low of 0.2232 with the 10-year Treasury yield at 3.20%. Copper-gold bounced back up while the 10-year yield continued to fall to 2.39% in early October 2010. The 10-year yield rose significantly from that low to close February 8, 2011 at a high of 3.74%. The ratio peaked two days earlier at 0.3396. (Figure 5)



Figure 5. Source: DoubleLine, Bloomberg

On March 19, 2012, the 10-year peaked at 2.38% and rallied back down below 2%. This rally in rates was not corroborated by the ratio, which was at 0.2343 on March 19, 2012. When the 10-year hit its low close of 1.39% on July 24, 2012, copper-gold had fallen only to 0.2127. The 10-year rose some from the bottom, but it took the Taper Tantrum to bring the 10-year back in line with the ratio. Similar to the previous example, both the copper-gold and the 10-year peaked on December 31, 2013 at 0.2853 and 3.03% respectively. (Figure 6)



Figure 6. Source: DoubleLine, Bloomberg

The average home contains 400 pounds of copper that is used for electrical wiring, pipes and appliances. The average car contains 50 pounds of copper.

Source: European Copper Institute

One study found that the Atlantic and north Pacific oceans contain about one gram of gold for every 100 million metric tons of seawater, although the study found variations by a factor of up to 3 in different parts of the oceans. Setting aside that wide variation, the study would suggest the possibility of about 43 grams of gold per cubic mile or 14 million metric tons in the oceans.

K. Kenison Falkner, J.M. Edmond, “Gold in Seawater,” *Earth and Planetary Science Letters*, May 1990

The Egyptians used the ankh symbol to denote copper in their system of hieroglyphs. It also represented eternal life.



Source: European Copper Institute

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Copper-Gold and the 10-Year Treasury Yield: Case Histories (cont'd)

Similar occurrences were the downturn in the ratio in May 2015 before the 10-year rallied, and the rise of copper-gold in June 2017 before the 10-year sold off. (Figure 7)

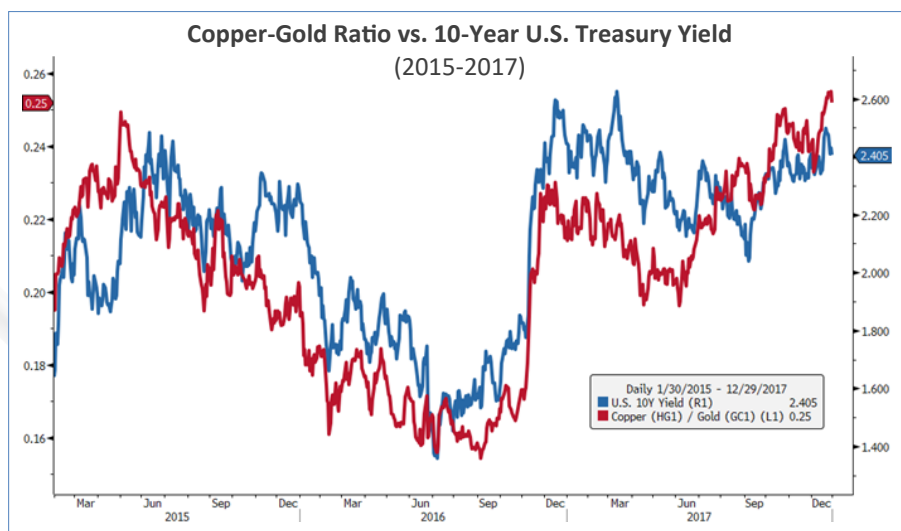


Figure 7. Source: DoubleLine, Bloomberg

In 2018, copper-gold fell in early October while the 10-year hovered around 3.20%. It wasn't until a month later when the 10-year finally followed by rallying into the end of the year. (Figure 8)



Figure 8. Source: DoubleLine, Bloomberg

Conclusion

The copper-gold ratio is the quotient of the price per pound of copper divided by the price per troy ounce of gold. The ratio's absolute level is irrelevant. What matters is its direction – and whether the yield on the 10-year Treasury moved in the same direction or diverged. In past episodes of divergence, the 10-year yield has eventually tended to follow suit of copper-gold.

The power of copper-gold, however, is not absolute. All market indicators are subject to “noise,” or volatility with no useful signals. As a result, these gauges can flash “false positives” or “false negatives.” Copper-gold likewise can send miscues at times. With those caveats in mind, copper-gold merits a place on DoubleLine's dashboard of market gauges. ■

Citations

- ¹ The base metal copper combines with a variety of secondary metals, including aluminum, arsenic, tin, nickel and zinc, to create bronze and other alloys such as brass and cupronickel. The earliest bronze artifacts, made of alloys of copper with arsenic and tin, date from 4500 BC in Anatolia (modern Turkey) and Persia (modern Iran). Tin-bronze, stronger and more easily cast than arsenic bronze, would form the foundation of the Bronze Age, which first emerged in the Near East around 3300 BC. See CC. Lamberg-Karlovsky, Philip L. Kohl, 1971, "The Early Bronze Age of Iran as Seen from Tepe Yahya," *Expedition* magazine, Volume 13 Issue 3-4. <https://www.penn.museum/sites/expedition/the-early-bronze-age-of-iran-as-seen-from-tepe-yahya/> Also see Erkan Fidan, Deniz Sari and Murat Türkteki, "An Overview of the Western Anatolian Early Bronze Age," *European Journal of Archaeology*, 18 (1) 2015, 60–89.
- ² According to the consensus among Egyptologists, although still debated, Menes, also known as Narmer (c. 3100 BC), was the first recorded pharaoh of ancient Egypt as well as enactor of the first gold standard. "Menes assigned a ratio of 2½ to 1 for silver in relation to gold. This apparently low valuation of gold is explained by the fact that the Egyptians had no native silver and consequently prized it highly," Jennifer Marx, *The Magic of Gold*, p. 44 (1978). While sovereigns have with varying degrees of success endeavored to fix gold-silver exchange rates, throughout history, the two metals have had "a complex, incestuous, and occasionally violent cohabitation" within bimetallic money systems, Peter Bernstein, *The Power of Gold*. Since the Nixon administration ended the foreign redemptions of the U.S. dollar in gold in 1971, the gold-silver ratio has varied between a low of 15 in December 1979 and a peak of 99 in January 1991. <https://www.macrotrends.net/1441/gold-to-silver-ratio>.
- ³ Croesus, king of Lydia (c. 560-546 BC), is credited with the invention of the first bimetallic coinage, minted from gold and silver, an innovation which would next spread to the neighboring Ionian Greeks on the western coast of Anatolia. In *A History of Money* (4th edition 2016), p. 64-65, Glyn Davies (1919-2003) described Lydia and Ionia as "the birthplace and nursery, respectively, of coinage."
- ⁴ In the United States, private ownership of gold bullion in 1933 was banned by executive order of President Franklin Delano Roosevelt and not legalized until 1974. The Bretton Woods agreement of 1944 wrote the final chapter of the gold standard. Signatory countries agreed to fixed exchange rates to the U.S. dollar, with foreign governments receiving the privilege to redeem their paper dollars in gold from the U.S., holder of the largest gold reserves. The end came under the administration of U.S. President Richard Nixon. "Foreigners' liquid claims on US dollars increased tenfold from around \$7 billion in 1953 to around \$70 billion in 1971. Over the same period US Gold reserves fell from over \$22 billion to less than \$11 billion. The inescapable decision facing the US authorities was taken on 15 August 1971 when convertibility of the dollar at the fixed price of \$35 per ounce of gold was ended," Davies, pp. 465-466.
- ⁵ Elwell (2011) has divided U.S. currency history into six regimes: basically silver standard (1792-1834), basically gold standard (1834-1862), fiat paper money (1862-1879), true gold standard (1879-1933), quasi-gold standard (starting in 1933 and progressively abandoned 1967-1973) and pure fiat money (1973-present). Fiat paper owes its use as money solely to government decree; it is not convertible into a precious metal and possesses no intrinsic value. The United States first abandoned the gold standard for fiat money to meet the financing needs of the Civil War (1861-1865). After the end of the war, the government gradually withdrew from circulation the non-convertible legal tender, called "greenbacks" for the color of the paper bills, and issued gold-backed dollars. Craig K. Elwell, "Brief History of the Gold Standard in the United States," Congressional Research Service, June 23, 2011.
- ⁶ Reality appears to fall short of the perception of gold as a currency hedge. In a comparison of gold betas of seven developed-market currencies from 1975 through 2012, Erb and Harvey (2013) found gold did not serve as a currency hedge. Claude B. Erb and Campbell R. Harvey (2013), "The Golden Dilemma," *Financial Analysis Journal*, Volume 69, Number 4, CFA Institute. <https://www.cfapubs.org/doi/pdf/10.2469/faj.v69.n4.1>
- ⁷ Copper also is recyclable. "Unlike other commodities such as energy or food, copper is not 'consumed'. Copper is one of the few raw materials which can be recycled repeatedly without any loss of performance," International Copper Study Group, *The World Copper Factbook*, (2018), p. 8.
- ⁸ Ibid, p. 50.
- ⁹ The Edwin Smith Papyrus, an ancient Egyptian medical manual dated to c. 1600 BC, recommends the stitching of wounds with needles made of copper and silver and the treatment of inflamed wounds "with herbs and green pigment, a copper salt that would have had some anti-bacterial effect." Michael R. Zimmerman, "Practicing Medicine in Ancient Egypt," *Juniata Voices*, Volume 17 (2017). <https://www.juniata.edu/offices/juniata-voices/media/volume-17/vol17-Zimmerman.pdf>
- ¹⁰ *The World Copper Fact Book* (2018), p. 8.
- ¹¹ Erik Norland, "Taking the Pulse of Dr. Copper for 2019," Chicago Mercantile Exchange Group website, November 29, 2018. <https://www.cmegroup.com/education/featured-reports/taking-the-pulse-of-dr-copper-for-2019.html>

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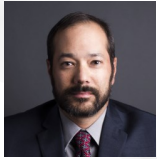
- ¹² Li Keqiang, premier of the People's Republic of China, as related by Bloomberg Financial LP's economics unit, once told a U.S. diplomat that he preferred to look at bank lending, rail freight and electricity consumption to track growth in China. At Peking University, Li earned a Ph.D. in economics in 1995. His doctoral dissertation, "On the Tri-structure of China's Economy," was awarded the Sun Yefang Prize, China's highest honor in the academic field of economics. "People first: Li Keqiang's governance philosophy," *The China Times*, December 24, 2012
- ¹³ Peter Bernstein, *The Power of Gold: The History of an Obsession* (2000).
- ¹⁴ Including the gold cargos of thousands of shipwrecks, forever lustrous, immutable and immune to the corrosive power of the salty sea.
- ¹⁵ Atomic mass approximates the number of protons and neutrons in an atom.
- ¹⁶ The World Gold Council estimates human activity had extracted 190,040 tons of gold as of the end of 2017. See "How much gold has been mined?" <https://www.gold.org/about-gold/gold-supply/gold-mining/how-much-gold> In the first nine months of 2018, mine production of gold totaled 2,426 tons. See *GFMS Gold Survey 2018: Q3 Update & Outlook*, a publication of Thomson Reuters.
- ¹⁷ Statista: The Statistics Portal, "Chile's copper mine production from 2006 to 2017 (in 1,000 metric tons)," <https://www.statista.com/statistics/254845/copper-production-of-chile/>
- ¹⁸ Storage capacity, of course, is not a guarantee of value. For example, gold's price per troy ounce fell more than 40% from an all-time high of \$1,900 on September 5, 2011 to a subsequent low of \$1,051 on December 17, 2017.
- ¹⁹ This is not to argue for gold as an inflation hedge. "Over practical investment horizons, gold is an unreliable inflation hedge," Erb and Harvey (2013) For reading on diversified commodities as an inflation hedge, see Ryan Kimmel, "Surfing with the Tides: The Macroeconomic Case for Active Asset Allocation," DoubleLine "Thought Leadership" series. <https://doubleline.com/2019/03/surfing-with-the-tides-strategic-asset-allocation/>

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The Power of Copper-Gold: A Leading Indicator for the 10-Year Treasury Yield

Biographies



Jeffrey Mayberry
Co-Portfolio Manager, Macro-Asset Allocation, DoubleLine

Mr. Mayberry works in portfolio management and trading for derivatives-based and multi-asset strategies. Mr. Mayberry holds a BS in Engineering from Harvey Mudd College and an MS in Financial Engineering from the Peter F. Drucker Graduate School of Management at Claremont Graduate University.



Fan Zhang, Ph.D.
Information Technology Department, DoubleLine

Mr. Zhang is a technology programmer specializing in asset-backed security analysis and is responsible for structured product modeling and analytics platform development at DoubleLine. He holds a BS and MS in physics from Peking University in China and an MS and a Ph.D. in physics from University of California, Los Angeles.

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Important Information Regarding DoubleLine’s Investment Style

DoubleLine seeks to maximize investment results consistent with our interpretation of client guidelines and investment mandate. While DoubleLine seeks to maximize returns for our clients consistent with guidelines, DoubleLine cannot guarantee that DoubleLine will outperform a client’s specified benchmark. Additionally, the nature of portfolio diversification implies that certain holdings and sectors in a client’s portfolio may be rising in price while others are falling; or, that some issues and sectors are outperforming while others are underperforming. Such out or underperformance can be the result of many factors, such as, but not limited to, duration/interest rate exposure, yield curve exposure, bond sector exposure, or news or rumors specific to a single name.

DoubleLine is an active manager and will adjust the composition of clients’ portfolios consistent with our investment team’s judgment concerning market conditions and any particular security. The construction of DoubleLine portfolios may differ substantially from the construction of any of a variety of bond market indices. As such, a DoubleLine portfolio has the potential to underperform or outperform a bond market index. Since markets can remain inefficiently priced for long periods, DoubleLine’s performance is properly assessed over a full multi-year market cycle.

Important Information Regarding Client Responsibilities

Clients are requested to carefully review all portfolio holdings and strategies, including by comparison of the custodial statement to any statements received from DoubleLine. Clients should promptly inform DoubleLine of any potential or perceived policy or guideline inconsistencies. In particular, DoubleLine understands that guideline enabling language is subject to interpretation and DoubleLine strongly encourages clients to express any contrasting interpretation as soon as practical. Clients are also requested to notify DoubleLine of any updates to client’s information, such as, but not limited to, adding affiliates (including broker dealer affiliates), issuing additional securities, name changes, mergers or other alterations to Client’s legal structure.

DoubleLine Group is not an investment adviser registered with the Securities and Exchange Commission (SEC).

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